VOL. XXVIII. JULY, 1859. No. 82.

Published the first day of every second month, price $5 per year.

THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

PROFESSORS B. SILLIMAN, B. SILLIMAN, JR.,

AND

JAMES D. DANA,

IN CONNECTION WITH

PROF. ASA GRAY, OF CAMBRIDGE,
PROF. LOUIS AGASSIZ, OF CAMBRIDGE,
DR. WOLCOTT GIBBS, OF NEW YORK.

VOL. XXVIII.—[WHOLE NUMBER, LXXVII.]

SECOND SERIES.

No. 82.—JULY, 1859.

WITH A PLATE.

NEW HAVEN: EDITORS.

1859.

E. HAYES, PRINTER.

POSTAGE PREPAID AFTER THE PAYMENT OF THE YEAR IS RECEIVED.

Postage, if paid quarterly in advance, under 3000 miles 3 to 3½ cts.—The Numbers will be sent to subscribers FREE OF POSTAGE after receiving the payment for the current year.

THE AMERICAN JOURNAL OF SCIENCE is published every two months, on the 1st of January, March, May, July, September and November, in Numbers of 152 pages each, making Two Volumes a year. Subscription price $5 a year, in advance.

1st Ser., 1818-1845, 50 vols., including a General Index. Edited to 1838 by Prof. B. SILLIMAN; after July, 1833, by Prof. B. SILLIMAN and B. SILLIMAN, Jr. Price for complete set, unbound, - - - - - - - - - - - - $100 00

2nd Ser., commenced January, 1846, by Prof. B. SILLIMAN, B. SILLIMAN, Jr., and J. D. DANA. Price for the 25 vols. published, unbound, - - - - $50 00

Volumes 10 and 20, of the 2nd Series, contain each a GENERAL INDEX to the preceding 10 volumes.

*** B. SILLIMAN, Jr., and J. D. DANA are the present proprietors of the Journal, and it is requested that all communications and remittances for this work, be addressed to SILLIMAN & DANA, New Haven, Conn.

☞ REMITTANCES BY MAIL AT THE RISK OF THE PROPRIETORS

This Journal may be purchased of the Editors, and of the following Booksellers—

New Haven,	G. B. BASSETT & Co. 115 Chapel st.	*Montreal,*	B. DAWSON.
		New Bedford, Mass.,	C. & A. TABER.
Albany, N. Y.,	LITTLE & Co.	*New Orleans,*	J. C. MORGAN.
Boston, Mass.,	LITTLE & BROWN. A. WILLIAMS & Co. CROSBY & NICHOLS.	*New York City,*	C.S. FRANCIS & Co. WILEY & HALSTED JAMES MILLER.
Baltimore, Md.,	N. HICKMAN.	*Paris, France,*	HECTOR BOSSANGE.
Buffalo, N. Y.,	ELIHU PHINNEY.	*Philadelphia, Pa.,*	PARRY & MCMILLAN
Hartford, Conn.,	F. A. BROWN.	*Pittsburg, Pa.,*	WILSON & Co.
Germany,	B. WESTERMANN & Co., New York, and BERNHARD HERMANN, Leipsic.	*Providence, R. I.,*	GEO. H. WHITNEY.
		Rochester, N. Y.,	E. DARROW & Brother.
		Salem, Mass.,	HENRY WHIPPLE.
London,	TRUBNER & Co. H. BAILLIÈRE.	*Savannah, Ga.,*	W. T. WILLIAMS.
		Troy, N. Y.,	S. F. HOYT.
Middletown, Ct.,	A. PUTNAM.	*Toronto, C. W.,*	A. H. ARMOUR& Co

TRAVELLING AGENTS whose receipts are acknowledged as good:—

HENRY M. LEWIS, of Montgomery, Alabama,—for Alabama and Tennessee,—assisted by C. F. LEWIS, JAMES O. LEWIS, and SAMUEL D. LEWIS.

C. W. JAMES, Cincinnati, Ohio, is our general collecting agent for the Western States and Texas, assisted by H. J. THOMAS, W. RAMSEY, WM. H. THOMAS, THOS M. JAMES, A. L. CHILDS, Dr. WM. IRWIN, and RICHARD LEEKE. Receipts of either will be good.

ISRAEL E. JAMES, 182 South Tenth street, Philadelphia,—assisted by WM. H. WELD, JOHN COLLINS, JAMES DEERING, J. HAMMITT, JOS. BUTTON, EDWARD W. WILEY, WILLIAM L. WATERMAN, E. A. EVANS, THOS. D. NICE, ROBERT W. MORRISON, H. J. RIDDICK, P. W. MACKEN and Mr. TOBIN.

ISAAC MARTIN of Chester County, Pa., ALEXANDER MEARNS of Buttermilk Falls, Orange County, N. Y., and Rev. ULRIC MAYNARD of Castleton, Vt.

TO CORRESPONDENTS.

Twelve copies of each *original communication*, published in this Journal, are if requested at the disposal of the author. Authors should specify at the head of their MSS. the number of extra copies desired; it is too late after the forms are broken up.

The titles of communications and the names of authors must be fully given. The articles intended for any number should be sent in, if possible, by the time the preceding number is issued, or the pages may be preoccupied. Notice always to be given when communications offered, have been, or are to be, published also in other Journals

THE

AMERICAN

JOURNAL OF SCIENCE AND ARTS.

[SECOND SERIES.]

Art. I.—*On a new Sounding Apparatus for Deep-sea Sounding*; by Prof. W. P. Trowbridge, Assistant U. S. Coast Survey.—With a Plate.

[Published in this Journal by permission of the Treasury Department.]

Communication addressed to Prof. A. D. Bache, Supt. U. S. Coast Survey, dated U. S. Coast Survey Office, Washington, D. C., April 6, 1859.

Dear Sir,—In my report to you of May 31, 1858, I had the honor of presenting the results of an investigation of the laws of descent of heavy bodies in the ocean, under the conditions required in deep-sea sounding.

The object of that investigation was to ascertain and develop fully the causes of failure and error in deep-soundings, and to devise a more certain and reliable mode of measuring the depth of the ocean, in the off-shore hydrography of the Coast Survey, and especially in the swift current of the Gulf Stream.

I have now to present for your further consideration a sounding apparatus based upon the developments given in my former report, and the result of further study and experiments on the subject.

The distinguishing feature of the method herein described, though exceedingly simple in its application, has never before been proposed, inasmuch as its necessity could hardly have been felt, without a careful analysis of the circumstances of descent of the sounding lead and line.

In the method of sounding heretofore employed, the influence of the friction of the water upon the line, or "endwise resist-

ance" as it is called by Prof. Airy, was known to exist, but the amount of this endwise resistance in pounds, and its ultimate effects at great depths, had not been determined. It was supposed that by making use of a weight of thirty or forty pounds and a small fishing line, this resistance would be reduced to an inappreciable amount, or at least that its effect in retarding the descent of the lead would not be sufficient to destroy confidence in the results.

It appears, however, from the investigations referred to, that a weight, such as is ordinarily used in sounding, will be practically held in suspension at no very great depth, even when the line used is the smallest that will sustain the weight with safety in the air; and in confirmation of this conclusion, the fact is well established, that, notwithstanding repeated experiments made by the most skillful officers and with the utmost care, the bottom of the ocean has never been reached in its deepest parts; and even where the bottom has been attained and specimens brought to the surface, the uncertainties of the results have given good grounds for controversy with regard to the depth.

These failures and uncertainties do not arise from the magnitude of the distance to be measured, nor from the impenetrability of the fluid through which the lead has to pass: distances infinitely great and infinitely small in the universe above and around us, have been measured with precision; and the unexplored depths of the ocean are occupied by a medium freely and equally penetrable at all depths. Yet in this field, a field daily traversed by the commerce of the world, a distance of a few miles only has baffled all attempts to measure it.

The difficulty lies in the simple cause stated above, viz. the "endwise resistance" or friction upon the sounding line, which prevents the lead from going to the bottom where the depth is great.

The apparatus which I have devised, is designed to avoid this friction upon the line, while at the same time the line is not dispensed with, but is made use of, as in the ordinary mode.

Before describing this apparatus I will briefly refer to some of the results given in my previous report on this subject.

The rate of descent of an iron globe or sphere, as the simplest geometrical form, was first determined when falling freely in the ocean, and it was found that a sphere will attain a certain maximum velocity, within twenty-five feet of the surface, which velocity will be kept up without sensible increase or diminution to the bottom.

For a 32 lb. iron shot this uniform velocity is about sixteen feet per second.

The conditions of descent when a small line is attached to the sphere and drawn down with it, were then discussed, the line

being uncoiled from a reel on the deck of the vessel, and drawn down by the weight of the sphere. The friction of this line in the water causes a remarkable change in the rate of descent. Nearly the same maximum velocity at starting is attained, but the velocity becomes rapidly reduced, until the sphere becomes suspended nearly motionless in the water.

Taking the simple case of a 32 lb. shot attached to a small fishing line, the shot attains its maximum velocity of sixteen feet per second within twenty-five feet of the surface, but before a hundred fathoms of the line is drawn into the water, this velocity is reduced to eight feet per second—a diminution of half the velocity from the friction of one hundred fathoms of line. At five hundred fathoms the velocity is again reduced half, or to four feet per second; and at three thousand fathoms to about one foot per second. *Whereas at this depth, if there is no line attached, the shot will fall with its original velocity of sixteen feet per second undiminished.* Below this depth we may determine, in the same way, the circumstances in the two cases: the shot falling freely still retains its uniform velocity of sixteen feet per second at four, five, and six thousand fathoms depth, while with the line attached, at five thousand fathoms the velocity is reduced to a few inches per second, and at six thousand fathoms the descent is not perceptible under ordinary circumstances.

The time of descent becomes an important element also in practice; in the two cases given, the shot falling freely will descend to the depth of three thousand fathoms in twenty minutes, and to the depth of six thousand fathoms in forty minutes. While with the line attached, it will require two hours to descend three thousand fathoms, and eight hours to descend six thousand fathoms. These effects were shown to be due to the friction alone; the amount of which in pounds, was determined for different cases, in which different forms of weight and different sizes of lines were used; and the entire inapplicability of the ordinary mode of sounding for great depths, and even for ordinary depths, where the object is to obtain a correct knowledge of the depths, was demonstrated.

Methods have been proposed in which a line is dispensed with, by detaching a float at the bottom, when the plummet strikes, and watching for the return of the float to the surface; but this is impracticable, as there is no material applicable, within our knowledge, that will float to the surface from the bottom of the sea, on account of the great pressure, which condenses the bulk, so us to render bodies specifically lighter than water at the surface, heavier than water at even moderate depths.

A line must therefore be used to bring back to the surface any machine by which the depth may be registered in the descent.

And the motion of this line in an extended form in the water must be avoided.

The apparatus which I have devised is designed to secure this object,—by attaching to the sinker a tube or case in which the sounding line is compactly coiled, and from which it will be discharged freely, thus causing the plummet to carry down the *coil*, while one end of the line is held fast at the surface; the line being uncoiled from the descending sinker in the manner that a spider falling from a height gives out a thread in his descent by which he retains communication with the point above to which the thread is attached. The motion of the line in an extended form through the water being thus avoided, all the conditions of free descent are secured, and the plummet will descend to the greatest depths with a rapid and uniform velocity.

The depth is ascertained in the manner heretofore known as Massey's method, by a helix or curved blade, which is caused to revolve, by the motion of the apparatus through the water. Instead of Massey's indicator however, which from its faulty construction does not give accurate results, I have adapted Saxton's Current Metre, a much more delicate instrument, to this purpose.

A specimen tube is also used differing somewhat from those now in use, in construction but not in its essential points.

The lower end of the line is attached to the register and to the specimen-box which weigh together only two or three pounds, and as the line is hauled in from the bottom it brings up the register and specimen-box, leaving the plummet and attached case at the bottom.

The details of construction are shown in the accompanying drawings and description of the apparatus.

Besides overcoming the principal difficulty in sounding, there are other important advantages secured by this arrangement which simplify rather than complicate, the problem. These are as follows:

First, there is no strain upon the line, in the descent, except from its own weight, no matter to what depth or with what velocity, the plummet may descend.

It is possible therefore to employ a very small line; a single thread of silk may in fact be extended to the bottom of the ocean. This permits of the use of a line, which may be coiled compactly within a small space, the strength of the line being made just sufficient to insure its being hauled in with safety, bringing up at the same time the specimen-box and the register. The strain brought upon it, in hauling in, will depend upon the velocity, of the upward motion, which may be regulated accordingly.

Secondly, a *rapid* and *uniform* descent being secured, the indications of a revolving register will be reliable when attached to this plummet; while in the present mode of sounding the slow motion of descent at great depths, renders such a mode of registering the depth uncertain and unreliable.

Thirdly, there being no strain upon the line in the descent and the motion being *uniform*, it is practicable to determine the depth by the *time of descent*, making use of a small insulated wire as a sounding line, and determining the instant that the weight strikes the bottom by an electrical signal transmitted through the line. An apparatus was devised as long since as the year 1845, for ascertaining the moment when the weight strikes the bottom, by electricity, but in the mode of sounding heretofore employed, no particular advantage would result from this, while the danger of breaking the electric continuity is very great owing to the strain brought upon the line in the descent; and the plummet as now used descends with such a varying velocity, that even with the time of descent given, no calculation will give the depth. The method has therefore never been put in practice. Whereas, in the method proposed, there is no strain upon the line in its descent, and the plummet will fall through each successive hundred fathoms in the same time; *the time of descent will thus furnish a simple means of calculating the depth.*

In this process it will not be necessary to recover the line, and the time required to sound the ocean at any point, need only be that required for the plummet to sink to the bottom, moving with any velocity which may be desired.

I have made many experiments on the best method of coiling the line so as to secure its uncoiling with certainty, and without the possibility of strain upon the line, or the occurrence of a kink.

I have also given much attention to the quality and size of line to be used: upon these points, the practical working of the apparatus in a certain degree depends, but being merely mechanical questions they are easily settled. They are fully discussed in the description which accompanies the drawings.

The importance of the problem, which is thus sought to be solved, in connection with the survey of the coast, has never been questioned. A knowledge of the configuration of the bottom of the sea, adjacent to the coast, is necessary to the solution of many questions of importance to navigation, and to science, and especially that of the ruling feature of the Atlantic coast, the Gulf Stream; but besides these considerations the question has become one of great public interest in connection with the laying of submarine telegraphs; the risk of such enterprises being diminished in proportion to the accuracy with which the depth of the sea is known at every point of any proposed

line; and the ultimate practicability of such operations across the Atlantic being yet to be demonstrated by new and more accurate soundings.

DESCRIPTION.

The accompanying plate is a photographic copy of a drawing made from the first instrument constructed. Some slight modifications have since been made in the mode of attaching the register but without affecting the general design.

PLATE I.

Fig. 1. Represents the plummet as it appears in its descent.
T, the tube or case containing the coiled line.
W, the leaden or iron weight inserted in the bottom of the tube.
C, the conical cap.
R, the register in its place upon the cap.
L, the line.

Fig. 1 *a*. Represents a longitudinal section of the tube, weight and cap; showing the mode of coiling the line in balls, and the small specimen-box *s* passing through the hollow weight.

Fig. 2. Represents the register on a larger scale.
h h, the helices or blades.
r r, the register wheels.
g g, the locks for gearing and ungearing the wheels.

Fig. 2 *a*, represents the plan or horizontal view of the register, it being constructed so as to offer the least resistance in passing through the water.

Fig. 3, shows the detailed construction of the register wheels, and the helices.

From fig. 1, it will be seen that the form of the apparatus admits of rapid motion through the water. The weight is conical and elongated and the register presents the edges only, of brass plates to the water, and the line being uncoiled and discharged from the tube, there is no retarding force to the descent, from the line itself. Any desired velocity of desent may be given to the plummet by increasing or decreasing the weight W.

Fig. 1 *a*, shows the method of coiling the line.

There are various modes of doing this which are in common practice in twine and cotton factories; that which is here exhibited is the method of coiling in balls; all the balls exhibited in the tube being formed of one unbroken line, the line drawing out from the centre of each, until it is all drawn from the tube. The machinery for winding these balls is very simple; a drawing of that which I have used is herewith enclosed.

The essential points in the coiling are to coil the line in as compact a space as possible, and so as to ensure a certainty of discharge without danger of kinking. Two other modes of coiling are now under consideration, either of which may be better than the method by balls. One is to wind upon a spindle, and the other to lay the line in a sort of compound coil, directly in the tube. All these methods are now practised in the factories on a large scale, for winding twine and cotton.

The line used should be about five hundredths of an inch in diameter and as strong as it can be made of that size. A braided line of Holland

flax, or silk of five hundredths of an inch in diameter, may be made to bear a strain of 40 or 50 lbs.; which is abundantly strong for the purpose, as the weight and case are left at the bottom, the register and specimen tube only being brought up.

Tube.—The tube may be made of tin in sections of eighteen inches length, with stove-pipe joints and bayonet fastenings. The object of this is to adapt the length of the tube readily to the amount of line which it is to contain. A tube four inches in diameter will contain nearly a mile of line to each foot of the tube.

Sinker and Specimen-tube.—The sinker is made of cast iron or lead of any desired weight, depending upon the desired velocity of descent. A weight of 25 lbs. has been adopted. The sinker is conical and is inserted into the lower end of the tube containing the line and fastened to this tube by screws or by a bayonet joint and fastening. The weight has a conical hole or cavity through its entire length, through which the small specimen-tube passes in the manner shown in the drawing. The specimen-tube is a tube of thin brass passing through the weight and attached to the lower end of the line within the large tube. This specimen-tube is fitted with a valve opening upwards in the bottom, which closes when the tube is drawn up, thus retaining the mud which is forced into the tube when the weight strikes bottom. The specimen-tube fits loosely in the hollow of the weight, so that it may be easily drawn out as the line is hauled in.

Cap.—The cap is used for two purposes; to contract the upper end of the tube containing the line, so that the line cannot rise in bulk out of the tube, and for supporting the register. It is formed in the shape of the frustum of a cone, cut away on one side as well as open at the top, so as to allow the line to be discharged freely. A flat strap is fastened to the top of the frustum nearly in the line of the axis of the tube, and upon this strap the register is set as shown in the drawing; the register is kept in its place by loose collars.

Register.—The apparatus for measuring the depth consists of a helix or curved blade attached to a vertical axis, and wheels gearing into an endless screw upon this axis. The revolutions of the helix caused by the motion through the water are communicated to the wheels which are graduated so as to indicate the number of revolutions of the helix.

Two registers are attached to one plummet by attaching them together in the manner shown in fig. 2, by means of brass plates. The blades are made to turn in opposite directions and will operate as checks upon each other, and also counteract the effect of any rotary motion in the plummet.

The construction of the blades and wheels and the mode of gearing them with the endless screw are shown in fig. 3. The wheels are differential wheels, that is, they are concentric, one of them having one hundred teeth, and the other one hundred and one teeth. The cross-bar (*b*) has a slight motion carrying with it the wheels; this motion is governed by a spring *s*. To gear the wheels, the cross-bar is pressed towards the endless screw until the teeth gear with that screw and the bar is there locked, as shown in fig. 2, at *g g*. The revolution of the blade will now cause both wheels to turn, and after one hundred revolutions the wheels will be found separated by one tooth or one division. The differences thus measure hundreds of revolutions.

In the register from which the drawings were made, the blades revolve once in two feet; one hundred revolutions will therefore correspond to two hundred feet, or one division of the scale of the register to thirty-three fathoms.

When the register is hauled up, the arms at *g g*, fig. 2, drop, and the springs cause the wheels to ungear and fly back, where they are held motionless by a projecting point at *n*, fig. 3. The arms are made to drop by means of a small wire which is attached to the cap as shown at *u* fig. 1; this wire is fastened to, or hooks over the ends of the arms, and when the register is drawn off, the arms fall.

Mode of attaching the line to the register and specimen-tube.—Before the line is put into the tube it is attached to the specimen-tube at a point four or five feet from the end of the line, the spare end is passed through the tube, and when the balls are all put in the tube the extreme end of the line coming out at top is attached to the register, after taking a few turns round the top of the strap, the register being in its place.

The line is thus attached to the register and specimen-tube only, and not to the large tube or weight. When the plummet strikes the bottom a part of the line will remain in the tube coiled; by hauling in the line this part will however be uncoiled, and on coming to the bottom of the coil, the specimen-tube will be drawn up through the large tube, and after the specimen-tube comes out the register will be drawn off the strap, and thus the large tube and weight will be disengaged from the line, specimen-tube, and register; and by continuing to haul in, the register and specimen-tube will be brought to the surface.

The plummet on striking will, under most circumstances, remain sticking in the mud in an upright position.

ART. II.—*Notice of New Localities, and interesting varieties of Minerals, in the Lake Superior region: supplementary to the chapter on this subject, in Part* II. *of the Report of Foster and Whitney;* by J. D. WHITNEY.

SINCE the publication of the second part of our "Report on the Geology of the Lake Superior Land District," in 1851, some materials, illustrative of the mineralogy of this region, have accumulated in my note-books, which, in the present communication, I have put together in the alphabetical order of the minerals noticed, for convenient reference. A few of the facts here stated were communicated to J. D. Dana, for the last edition of his "System of Mineralogy," and are here repeated, with some additional remarks on the general mode of occurrence or economical importance of the ores and minerals mentioned.

Analcime.—This mineral is quite abundant on Keweenaw Point, and has also been noticed by me on Michipicoten Island; it does not appear to have been observed in the Ontonagon region. The finest locality, however, by far, is at the Copper Falls

and Northwestern mines; and, especially, at the last-named place, where work is, for the present, suspended. Both these mines are, in fact, on the same vein, the Copper Falls mine being to the north, and the Northwestern to the south of the great belt of crystalline, unproductive trap, which runs through the middle of Keweenaw Point. In this vein, analcime occurs in large and almost transparent crystals forming geodes in the greenish magnesian silicate which is the principal gangue of the vein. These crystals are all trapezohedrons, and sometimes occur an inch in diameter; they occasionally have a thin incrustation of chrysocolla. The analcime, at this locality, is almost always associated with the peculiar form of orthoclase, so common in the copper region, and which will be noticed farther on.

At the Old Copper Falls vein analcime has been found in radiated-fibrous as well as granular-massive forms, and of a bright red color.

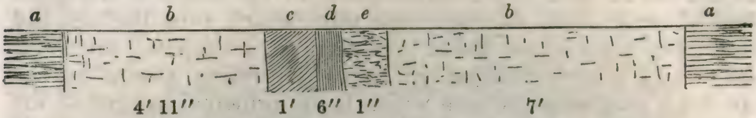
Apophyllite.—The foliated variety, or ichthyophthalmite, was found in great abundance in 1853 in the rubbish thrown out at the workings on the Prince vein, on the north shore. A variety in small, brilliant, deep-red crystalline scales or spangles, disseminated through calcite, forms curious and elegant specimens. The most usual occurrence of apophyllite at this locality is in large contorted plates, somewhat resembling the variety of calcite known as argentine. Crystalline specimens are occasionally met with at the Cliff mine, but none have been noticed in the Ontonagon district.

Barytes.—There are numerous veins of sulphate of baryta on the north shore of the Lake, and especially along that portion lying to the northwest of Isle Royale, as also on that island, and the smaller ones which lie near the main land to the westward of Thunder Bay. These veins vary in width from a few inches to several feet, and are usually made up of quite compact barytes without crystallization, and destitute of accompanying metalliferous ores.

The famous "Prince vein," on Spar Island, is one of the most conspicuous and interesting objects, at least in the eye of the mineralogist, in this region. As it makes its appearance on the south side of the island, on the precipitous face of the trap cliffs, which rise nearly vertically from the water, it may be seen from a distance of several miles out on the lake; and when shone upon by the sun, resembles a magnificent waterfall, its brilliant white contrasting strongly with the dark color of the trappean rocks in which it is enclosed.

The course of this vein is about N. 32° W., or nearly at right angles to the general trend of the coast of this portion of the lake. At the southern edge of Spar Island it is fourteen feet

and seven inches wide. Here the vein is made up of bands of calcite, crystalline quartz and barytes, as represented by the annexed cross-section.



a, a, trap; *b, b,* coarsely crystallized calcite; *c,* barytes; *d,* calcite with copper pyrites; *e,* quartz and calcite.

At the point where this section was taken the ore is confined to a band of calcite in the centre of the vein and about six inches in width. The metalliferous portion of the lode consists here of chalcopyrite and erubescite,—in small quantity, however, as compared with the amount of barren veinstone connected with these ores.

On the main land, about two miles distant, the vein reappears a little way back from the shore, where it is much split up; but when followed a few rods farther to the northwest it concentrates again, and appears to have a width somewhat greater than on Spar Island. A drift has been carried in on the vein for a distance of 165 feet, from which most magnificent crystallizations of amethystine quartz and calcite were obtained. An examination of the back of the drift shows that if workings should be resumed here, a rich harvest, for the mineralogist at least, would be gathered, the veinstone being highly crystalline in its texture. The metalliferous contents, however, seem to be chiefly limited to blende. At the point in the level where a winze has been sunk to the depth of 90 feet, and near the collar of the winze, a considerable quantity of native silver was obtained in fine laminæ between the joints of the blende. A large sum of money was expended here, after the discovery of the rich bunch of silver, but it does not appear that a second one was ever struck. A single minute point of native silver rewarded our patient search of hours among the veinstone for proof of the existence of the precious metal.

In no other vein in this neighborhood were any interesting crystalline minerals observed, although the exposures on the lake shore are usually good.

Chalybite.—This mineral has been observed by Dr. G. H. Blaker in the talcose slates near Marquette; it forms narrow strings and bunches in the veins of milky quartz which ramify through the slates. The quantity is not sufficient to make it of any economical importance.

The same mineral occurs, associated with chalcopyrite, in the quartz veins at Echo Lake, near Saut St. Marie. The geological position of these veins is the same as that of the Marquette slates.

Chrysocolla.—Handsome specimens are found in the Copper Falls vein, forming delicate stalactitic incrustations on the veinstone, and sometimes coating the crystals of analcime.

Chalcopyrite.—Veins of quartz containing this ore are numerous in the trappean rocks of the Azoic series, in the neighborhood of Echo Lake, about 15 miles east of Saut St. Marie. Copper pyrites is the predominating ore at the Bruce and Wellington mines on Lake Huron: it has also been found in veins in the Huron Mts., on the south shore of Lake Superior, where no mining has yet been carried on.

Copper.—The native metal is now the exclusive object of mining enterprise on Lake Superior, no veins producing *ores* being now worked, on either the north or the south shore. The sulphurets, however, are still mined on Lake Huron, in the Azoic rocks, a formation which has not been proved as yet on either shore of Lake Superior, to contain any workable vein of the native metal.

The largest mass of copper yet discovered on Lake Superior was in the 10-fathom level of the Minnesota mine, on the so-called "conglomerate lode," or the copper-bearing vein which lies between the trap and a thin bed of conglomerate that runs through the mining ground, and which has been opened to a depth of between 80 and 90 fathoms without ceasing to produce largely. This mass was 46 feet long, and is said by the superintendent of the mine to have weighed about 400 tons: a single cut across it exhibited a thickness of six feet of pure metallic copper. This mass was estimated to contain at least 90 per cent of the pure metal. The operation of cutting it up lasted thirty months.*

Almost all the specimens collected on Lake Superior as *crystallized copper*, are, in reality, not actual crystals, but only imitative forms produced by juxtaposition with the crystalline faces of some mineral substance, and usually of calcareous spar. The large masses which are seen in collections, and labelled "crystallized copper from the Cliff mine," usually exhibit only a few indistinct planes which can be referred to the crystalline force of the metal itself.

The finest groups of crystals ever obtained in the copper region were from the Old Copper Falls mine, a locality which has long ceased to be worked; and no other has furnished any specimens to compare with those found here.

The predominating form in these groups was the rhombic dodecahedron; but the octahedron was not of unfrequent occur-

* The size of the pieces into which the great masses are cut for convenient handling under ground and shipment is now much greater than it was formerly: blocks of copper weighing from 8000 to 9000 pounds are not unfrequently brought to the surface and sent off to the smelting works.

rence. The diameter of the perfectly formed crystals rarely exceeded one-fourth of an inch, although single crystals from this locality, octahedrons, have been seen as large as an inch across their bases. The finest single crystals, as far as ascertained, are from the Cliff mine, and are tetrahexahedrons. One in my collection, considered by many the most beautiful crystal ever found in the Lake Superior region, is about three-fourths of an inch in diameter, and nearly perfect.

The occurrence of native copper as a pseudomorph after aragonite, reported by Söchling* as from Lake Superior, may with the strongest probability be set down as an error. It is very likely that the pseudomorph in question was from Corocoro, South America, where interesting ones of this kind do occur. There is a very great tendency to confusion in the localities of American minerals sent to Europe, as every mineralogist on this side of the water has learned by experience. No aragonite has ever been found in the copper region, as far as I know. Native copper, as a pseudomorph of calcite, has been noticed by me in a single instance, in a specimen from the Old Copper Falls vein.

The specific gravity of the native copper, sawn from the interior of a large mass of the chemically pure metal, has been previously stated in our Report at 8·838; this is lower than that given by Erdmann and Scheerer† as the specific gravity of crystallized copper. The specific gravity of the copper smelted at the furnace near Detroit was found to be considerably less than that of the native metal. A piece sawn from the centre of an ingot, and showing no signs of any air-bubbles, gave a specific gravity of 8·601; another portion of the same ingot taken from near the surface gave 8·570; both pieces appeared, under the magnifying glass, equally free from bubbles.

This copper, which was smelted from masses brought from the Toltec mine, was found on examination to be chemically pure, with this exception, that it contained $\frac{3}{10000}$ of silver, about seven ounces to the 2000 lbs.

Datholite.—Fine crystals of this mineral have been found only at the locality on Isle Royale, which has long since ceased to be worked, the island being now entirely deserted by all except a few fishermen. There are several localities on Keweenaw Point, however, where it occurs in great abundance, but not, so far as I have observed, in handsome crystallizations. The gangue of the Hill vein, on the Copper Falls location, consisted, in a portion of its more northern extension, of a greenish magnesian silicate penetrated, in every direction and sometimes forming a sort of breccia, with branches and strings of datholite. It is usually massive, translucent, highly vitreous in lustre, and of a light

* Pogg. Ann., civ, 332.

† Erdmann and Marchand's Journal, xxvii, 194.

flesh-red color, owing to the presence of a minute quantity of suboxyd of copper diffused through it.

The veinstone of the Ontonagon region had seemed to be quite destitute of this mineral, and it was not until last summer that it was discovered by me in that district. At the Minnesota mine, among the vein-stuff thrown out, some singular nodules were observed looking like rusty cannon balls. On breaking one of these open and examining it, it was found to be datholite, in a singular and hitherto unobserved form.

The mineral is quite compact, breaking with a conchoidal fracture, perfectly white, opaque, and resembling in its physical character the purest and most close-grained marble. Its hardness = 4·5; specific gravity 2·983.

An analysis of this mineral by Prof. C. F. Chandler, gave the following results:

Silica,	37·41
Oxyd of iron and alumina,	·35
Lime,	35·11
Boracic acid (by loss),	21·40
Water,	5·73
	100·00

The quantity of datholite which is found on Lake Superior is very considerable, but it does not occur as a constant ingredient of the veinstone in any of the large mines now worked; and it is not probable that it will become of economical value for the extraction of the boracic acid it contains, however interesting it may be in a theoretical point of view, as connected with the origin of the cupriferous veins.

Hematite.—The purity of the mountain masses of iron ore, which are now extensively mined at various points from 14 to 17 miles west of Marquette, may be inferred from the following analyses recently made of specimens from the three principal mines, or quarries, as they may more properly be called. The specimens are, indeed, selected ones; but an inexhaustible supply of ore of the same quality could be obtained, without rejecting any considerable amount of the stuff which is quarried out, were it desirable to ship a perfectly pure ore. The average yield of the ore shipped would, in point of fact, fall but little below that given by the following analyses.

	I.			II.		III.	
	a.	*b.*	*c.*	*a.*	*b.*	*a.*	*b.*
Insoluble,	1·02	·80	·54	7·92	7·96	1·99	2·05
Iron,	69·41	70·22	69·96	64·42	64·01	68·81	
Oxygen and traces of lime, &c.,	29·57	28·98	29·50	27·66	28·03	29·20	

I. is ore from the Jackson, II. from the Cleveland, and III. from the Burt or Lake Superior mountain. The fragments analyzed were, in each case, broken from the different portions of

the same large specimen, one object being to ascertain what the variations in the quantity of oxygen were, in different portions of the same mass. I. *c.* is the mean of three closely-agreeing determinations.

In the above analyses, the iron having been precipitated from the chlorohydric acid solution by ammonia, the filtrate was evaporated to dryness and ignited, and in no case did the residuum amount to more than a few hundredths of one per cent. In I. *c.* and III. *b.* there was a weighable quantity of lime present, amounting, in each case, to 0·05 per cent. It was not possible, in any instance, to obtain a weighable amount of alumina. The oxygen was therefore determined by the loss, as giving more accurate results than could be obtained by the process of reduction with hydrogen. It appears, therefore, that these ores are mixtures of the peroxyd with a minute and varying portion of the magnetic oxyd.

Both the Burt and Cleveland Mountain ores show minute crystals of magnetite scattered through their mass; in the Burt ore these crystals are from $\frac{1}{20}$ to $\frac{1}{25}$ of an inch in diameter; in the Cleveland, so small as to be hardly visible without a magnifying glass. No sulphur or arsenic could be detected in any of the specimens examined. The insoluble portion consists of silica, with only traces of lime, alumina and magnesia: this silica is partly in combination with the iron in the form of a silicate of iron, and partly present in the form of grains of quartz. On the whole, it may be said with truth that these ores surpass in purity any known to exist elsewhere in the world in anything like the same quantity.

Leonhardite.—This mineral has been observed only in the Old Copper Falls vein, where it was very abundant; but a careful investigation would probably reveal its presence at other localities. An examination was made of this mineral to ascertain at what temperature it parts with a part or all of its water, with reference to H. Rose's investigations on Laumontite, which he has shown to lose a portion of this constituent at 100° C. The results gave on the mineral in small fragments:

Dried at	Loss of weight.
80°	1·46 per cent.
90°	0 "
100°	0 "
Ignition,	11·89 "

The 1·46 per cent is probably not essential to the constitution of the mineral; the loss by ignition agrees well with the formula which takes the oxygen ratio of the bases and silica as 4 : 9, and 12 $\dot{\text{H}}$.

Limonite.—This ore of iron has recently been discovered and for the first time on Lake Superior in any noticeable quantity.

It occurs at the Jackson iron mountain, where it forms beds of several feet in thickness, occupying depressions in the anhydrous ore, from the decomposition of which it may have been formed. The analysis gave the following results:

Silica,	6·54
Iron,	60·03
Water,	9·31
Oxygen and traces of lime and magnesia,	24·12
	100·00

No sulphur or manganese could be detected; the original ore appears to have been only partially converted into limonite, as the quantity of water given by the analysis is considerably less than that required to form a hydrous peroxyd of iron. It is used at the Pioneer Furnace, near the Jackson Mountain, and considered to aid in the reduction of the ore.

Manganite.—Handsome specimens of this mineral were given me by Dr. G. H. Blaker, of Marquette, as having been procured in that vicinity; the exact locality is not known to me.

Nickel and Copper, arseniuret of.—This is the same mineral noticed by T. S. Hunt (this Journal, [2], xix, 417), and afterwards more fully described in the Report of the Canada Geological Survey, 1853–6, p. 388. The result of my analyses, made two years ago, confirm entirely those already published by Mr. Hunt; the mineral, which appears homogeneous in composition, being in fact a mixture of the arseniurets of copper and nickel.

Two analyses of different specimens broken from the same mass gave as follows:

	I.	II.
Arsenic (by loss),		47·01
Copper,	14·56	20·94
Nickel,	33·35	31·24
Silver,		·24
Gangue,		·57
		100·00

Specific gravity 7·527.

In II. the quantity of arsenic required to form with the copper domeykite, and with the nickel copper-nickel, is 47·86 per cent, which agrees pretty nearly with that given by the analysis.

The specimens obtained by me on Michipicoten island in 1853, are in coarsely crystallized calcite, and form nodules having a structure in concentric layers. The portions selected for analysis appeared perfectly homogeneous and had almost exactly the color and general appearance of copper-nickel. This ore was obtained in mining for silver on the island, from the trappean rocks; but on examining the excavations it did not appear that there was any regular vein of this or any other metalliferous mineral, the ore occurring in irregular nodules disseminated through the trap. There is little reason to believe that either

nickel or silver occur at this interesting locality in sufficient quantity ever to become the object of a profitable mining enterprise. The beds of rock appear to be too thin, and their changes of lithological character too sudden, to admit of the development of well characterized veins.

Orthoclase.—In almost every collection of Lake Superior specimens may be seen bunches and geodes of minute reddish crystals, accompanied by native copper, calcite and the zeolites, the usual vein-minerals of that region; these crystals are usually labelled "stilbite," but they are, in reality, orthoclase, as is evident from their physical characters and chemical composition.

The mineral here referred to, which has, on casual inspection, but little resemblance to feldspar, is the same one noticed on page 102 of our Report, where an imperfect analysis of it is given. The peculiar interest attaching to this anomalous occurrence of the substance in question seemed a sufficient reason for completing its analysis, and adding some further remarks on its associations.

This mineral occurs in minute crystals which are rarely as much as one-tenth of an inch in length; they are rhombic prisms, but not very distinct, or brilliant enough to be measured by the reflecting goniometer. The angle of the prism is about 118°, or near that of *I* on *I*, in common feldspar. The terminations of these prisms are usually rough and indistinct, but formed by a single plane, probably $1i$; more frequently the crystals are aggregated together into a confused crystalline mass, the individuals being too minute and ill-defined to be made out without a magnifying glass. The mineral agrees in its physical characters with orthoclase, fusing before the blowpipe with some difficulty to a blebby glass.

The analysis gave:

Silica,	65·45
Alumina,	18·26
Oxyd of iron,	·57
Oxyd of manganese,	*trace*
Potash,	15·21
Soda,	·65
	100·14

The above results indicate, beyond the possibility of a doubt, that the mineral is really orthoclase.

The occurrence of feldspar as an associate of, and in intimate connection with, the zeolitic minerals, which form so large a portion of the gangue of the cupriferous veins, and, indeed, its presence at all in a vein-stone, is a matter of too much importance not to be dwelt upon. Instances of this kind are, as yet, sufficiently rare, and there are some points connected with the occurrence of the feldspathic element in the Lake Superior veins which add to the interest with which these specimens are invested.

Orthoclase has been recognized and described as occurring in the mineral viens of Schemnitz and Kongsberg,* although the possibility of such an association has, until within a few years, been hardly allowed. The well-established fact of the existence of feldspar as a pseudomorph, of the form of laumontite and of analcime, in the trap of the Kilpatrick Hills, near Dumbarton, Scotland, furnishes incontestible evidence of the possibility of the formation of this mineral in the moist way, and the phenomena exhibited on Lake Superior in connection with the association of feldspathic and zeolitic minerals, point as clearly to this conclusion as they do to the necessity of rejecting the igneous theory of the origin of the veins themselves.

The variety of orthoclase of which the analysis has been given above is found in almost all the mines, from the extremity of Keweenaw Point to the Ontonagon; but in the latter district it is most abundant. At the Northwestern mine, the association of orthoclase and analcime is almost constant, and there are few geodes which do not exhibit delicate crystallizations of the first-named mineral so situated with reference to the other as to lead to the conclusion that their formation must have been going on at the same time and under the same circumstances. The crystals of orthoclase are also, at this locality, frequently scattered, singly, over delicate incrustations of a very soft magnesian mineral, which hardens somewhat on exposure to the air, and which is probably saponite, but of which I have never been able to procure enough for an analysis. This mineral seems to have been the last formed of all the vein-minerals of this region.

At the Old Copper Falls vein, orthoclase, of a bright red color, occurs lining the interior of cavities in the gangue, and forming with associated calcite and crystallized copper, specimens of great beauty. The calcite, not unfrequently, has crystallized over the orthoclase in such a manner as to be colored deep-red by it. The same may be said in reference to the joint occurrence of natrolite and orthoclase at this locality. There is clear evidence here of the contemporaneous formation of the copper, natrolite, calcite and orthoclase.

In the Ontonagon region, the minerals associated with orthoclase are chiefly quartz, epidote and calcite. At the Aztec and Ridge mines, geodes lined with delicate crystallizations of these are not unfrequent. Minute crystals of scolecite or natrolite have been noticed in the same connection. At the Minnesota mine, the large crystals of quartz, formerly obtained there in abundance, were frequently encrusted with a thin layer of crystals of orthoclase.

It may be remarked, that the crystals of this mineral are, throughout the whole copper region, remarkably uniform in

* See Leonhard and Bronn's Jahrbuch, 1850, p. 43; also Bischof's Geology, ii, 330.

their size, color, and general habit. They are rarely more than a few hundredths of an inch in length, have the same crystalline form, and are, with rare exceptions, of a light reddish color.

Feldspar, in no instance, so far as has yet been observed, forms the bulk of the veinstone; it is only met with in comparatively minute quantity, although occurring in numerous localities. Only a single instance has been noticed where a crystal had a length as great as one-tenth of an inch, and this was an imperfectly formed one.

Note.—Weissigite, described by Jenzsch, is undoubtedly orthoclase, as suggested in Dana's Mineralogy, p. 513; this was found in a porphyritic amygdaloid, with chalcedony and quartz, and is spoken of by Jenzsch as the first known instance of the occurrence of a feldspathic mineral in an amygdaloidal cavity of a rock of this class.

Serpentine.—Well-characterized serpentine has not yet been found in the Lake Superior region; but a substance closely related to this mineral, and, in fact, differing from it chiefly by the substitution of protoxyd of iron, in a large but varying amount, for a portion of the magnesia, forms the head-land of Presqu' isle, near Marquette. An imperfect analysis of this rock was given in Foster and Whitney's Report, Part II, page 92. Since the publication of that analysis new specimens have been collected, and a more thorough examination made of it, of which the results here follow.

The substance is of a deep green color, so deep as to appear almost black; its powder is light greenish-gray. Its hardness is a little above that of common serpentine. It is readily attracted by the magnet, when broken into small fragments. In some specimens minute octahedral crystals of magnetic iron ore disseminated through the mass can be seen with the aid of the magnifying glass. The substance is readily attacked by chlorohydric acid, even in the cold, if finely pulverized; but a small portion of unattacked mineral remains behind when the insoluble residuum is treated with carbonate of soda in the usual way. It amounts to from two to six per cent, and appears to be an insoluble silicate mechanically mixed with the serpentine; it is probably hornblende, but has not been analyzed.

The analyses of three specimens collected at some distance from each other, gave the following results, as the composition of the soluble portion of the substance:

	I.	II.	III.
Silica,	36·95	37·25	
Magnesia,	33·07	28·67	14·83
Soda,	·97	1·16	
Protoxyd of iron,	16·50[a]	14·14	19·52
Peroxyd of iron,		6·75	12·90
Water,	10·40	10·89	
		98·86	

[a] Estimated as protoxyd.

In analysis II, in which all the ingredients are determined, as well as the relative amount of the oxyds of iron, the calculation gives, for the ratio of the oxygen of water, protoxyd bases and the silica, leaving out of consideration the peroxyd of iron as being a mechanical intermixture, the numbers $1:1{\cdot}49:1{\cdot}99$; or, almost exactly, $1:1\frac{1}{2}:2$, which is the ratio given by the analyses of serpentine.

Silver.—Native silver still continues to be found in considerable quantity, in connection with the copper, at the principal mines on Lake Superior, especially at the Minnesota and the Cliff. The amount obtained at the Minnesota in 1857, by the company, was $655.44: this, however, was but a small portion of what was really found, as the miners are well known to appropriate almost all the silver they discover. The metal has never been noticed by me in distinct crystals, except in one instance, namely, at the Copper Falls mine, where a few well formed cubes about one-tenth of an inch in diameter were obtained.

Most of the fine specimens of silver from the Lake have been associated with calcite, which is dissolved away by an acid, leaving the metallic mass exhibiting the impressions of the planes of this mineral, as is the case with the copper specimens, as before remarked.

Zeolites.—To close this article, a few remarks may be added on the occurrence of the zeolitic minerals in the Lake Superior region, and especially as vein-stones.

By far the most abundant zeolites of the copper-bearing veins are prehnite and laumontite, or the closely allied species, leonhardite. The cases are rare, however, in which either of these minerals constitutes the bulk of the gangue of a vein, except in the case of narrow strings and bunches of limited extent. Quartz and calcite are the predominating vein-minerals, the zeolites being decidedly subordinate to these, especially in the great, productive lodes. The zeolites, moreover, are chiefly confined to transverse veins, or those crossing the formations at a high angle: in the Ontonagon region, where the great lodes have the same strike as the beds of rock, zeolitic minerals are of comparatively rare occurrence in the vein-stone. In this class of veins quartz and silicious material greatly predominates over all the other minerals, and there is much more rock intermixed with the vein-stone proper. Datholite may be noticed in a few instances among the transverse veins, as forming the larger portion of the gangue near the surface; but in no such case has mining been carried to any considerable depth, so as to ascertain how far this state of things continued.

On the whole, the diminution of the zeolitic portion of the vein-stone is marked as the mines are extended downwards: the only crystalline mineral observed in a recent careful examination

of the Minnesota mine, at a depth of from 70 to 80 fathoms, was calcite. Traces of what appeared to be laumontite were noticed along the selvages of the lode, which at this depth is quite as rich in copper as anywhere above, but the lode seemed to be very compact in its texture and no other zeolite was seen in it.

The entire, or almost entire, absence of some of the more common zeolites from the Lake Superior region is worthy of notice. Those minerals which are most characteristic of the Nova Scotia trappean rocks are almost entirely wanting on the Lake. Neither chabazite, stilbite or heulandite have ever been observed by me in the copper region, on the south shore of the Lake.* The analogy of lithological character between the traps of Nova Scotia and those of Lake Superior, which has frequently been urged as a reason for considering them of the same geological age, and which has not yet been made evident by an analysis of the rocks themselves, fails entirely when considered with reference to the associated minerals.

Of the zeolites occurring on Lake Superior, pectolite, leonhardite and chlorastrolite appear, thus far, to be limited to a single circumscribed locality, while harmotome is reported in only a doubtful crystal. The only new zeolitic mineral noticed is chlorastrolite, which is quite common along the beach of Isle Royale, for a distance of two or three miles, but which has not been discovered at any other point on the Lake.

The occurrence of the zeolites on Lake Superior is not absolutely, although chiefly, confined to veins. All the fine specimens of crystallized minerals of this class have been obtained from the cupriferous veins, so that this may be considered as the normal mode of occurrence in this region. Where the trappean rocks assume an amygdaloidal structure, we have, occasionally, prehnite, chlorastrolite, etc., in radiating fibrous masses, filling the cavities; but quartz in the form of agate and chalcedony and calcite are much more common. There are occasional flat tabular masses of laumontite mixed with prehnite found lying in the direction of the lines of bedding of the trap, but these are thin and of limited extent. Many of the trap amygdules are filled with a mineral resembling chlorophæite and others with saponite. Most of the substances thus occurring are only to be recognized by chemical analysis, as they are generally finely fibrous or massive.

* These minerals are reported by Messrs. Owen and Norwood as occurring on the Minnesota shore of the Lake, west of Pigeon River, a region to which my explorations have not extended. I have, however, examined numerous specimens from that part of the Lake, without having discovered either of these zeolites.

ART. III.—*On some questions concerning the Coal Formations of North America;* by L. LESQUEREUX.

IT may perhaps be said that as everybody is now acquainted with the coal, with its essential constituents and the general laws of its formation, an attempt to offer to science something new or even interesting on the subject, must prove a fruitless task. This assertion has a semblance of truth only, for it is certain that some of the various and most important phenomena connected with the formation of coal are not satisfactorily, nor even at all explained. And as they are continually brought forward for discussion, either by lecturers or systematic geologists, the subject of the formation of coal, considered as a whole, has been obscured in such a manner that it is doubtful if the most essential facts on the subject, some of which may be considered as demonstrable, are not still looked upon by many as hypothetical and individual opinions. It is with these peculiar phenomena of the coal formations, and consequently with the exposition and the discussion of geological facts connected with them, that we have to deal in the first part of this paper.

As we cannot expect to come to a right understanding of the formation of coal without some acquaintance with the vegetation of whose remains it is made, our attention must necessarily to some extent be directed to the flora of the coal period. But it is not enough to know the peculiar nature, the anatomical and chemical constitution, of the coal plants. It is necessary to study them also in their geographical distribution, in the different coal basins of America and of other countries, and also in the successive strata of the coal at different geological horizons. And it would be desirable also to examine the vegetation of the coal in connection with other external influences, in order to become acquainted if possible with the climatic conditions that prevailed at the time of the coal formation.

The plan that we propose to follow may accidentally direct the discussion to some points which do not appear to have a close relation to the formation of the coal. But we must bear in mind that geological eras are not very distinctly limited; or at least that to have a true understanding of one of them it is necessary sometimes to examine the causes that have prepared it, or that may have brought it to a close.

The supposition that coal is a true mineral, formed in certain strata of our globe only by some chemical agency and without an accumulation of wood grown on the surface and buried afterwards, has been recently revived among us, though it had long since been put aside, and apparently forever, as contradicted by all the appearances of the coal deposits and by the nature of the

coal itself. It would be useless, again to show the groundlessness of an hypothesis to which nature does not give the slightest apparent support.

The supposition that the matter of the coal (the wood) was heaped in some hollows or basins by the agency of water, as by currents of the sea or of some river, or by some other external cause, hurricanes, partial or general floods, sinking of the ground covered with thick forests, &c., has been also generally abandoned as contradicted by general evidence. The reasons against it may be briefly enumerated. They are found: 1. In the stratification of the coal measures; and also of the coal itself, which upon close examination appears to have been formed by successive layers of matter. 2. In the presence of plants in the coal and in the shales above it, plants preserved in the integrity of their most minute and fragile parts, and in a position which shows that they have been buried at the place where they have fallen from the trees or the bushes and where they grew. 3. In the absence in the coal of any matter foreign to it, of sand, of mud, &c., the ashes of the coal being generally in exactly the same proportion as in the wood. 4. In the thickness of some beds of coal containing a quantity of matter far greater than could be furnished by a buried forest.

The theory of the formation of the coal by the heaping of consecutive layers of plants and trees grown in place, preserved in water and buried afterwards; or the peat-bog theory as it is called by some, is then the only one admitted now as satisfactorily explaining the process of formation of the coal. The analogy of formation between the peat-bogs of our time and the beds of coal of the old measures cannot be called a theory; it is a demonstrable fact. We can now see the coal growing up by the heaping of woody matter in the bogs. After a while we see it transformed into a dark combustible compound that we name peat or lignite according to its age. We then see it hardening either by compression, or by this slow burning in water that has been so well explained by the experiments of Liebig. Most of the peat bogs of Europe, at least the oldest, have at or near their bottom some plates or thin layers of hard, black matter, that ocular examination or chemical analysis fail to distinguish from true coal. We find besides in Holland, Denmark and Sweden, thick deposits of peat separated into distinct beds by strata of mud and sand, giving the best possible elucidation of the process of stratification of the coal measures.

It is not only in their general features that both formations are so much alike. But in the minutest accidents and even local peculiarities, their agreement is clear and unquestionable to one who has studied the formations of the peat bogs of our time. We quote a few examples.

An author, speaking lately of the formation of the coal, mentions the presence in the coal of *wedge-shaped masses of vascular tissues found imbedded in the midst of the more structureless bituminous matter of the coal.* He accounts for this fact by supposing that these tissues are the remains of floated logs, which have finally become imbedded in the carbonaceous matter below. This supposition is rather an extraordinary one. If the coal has been formed like the peat bogs, there can not be any *floated* logs in the compound. If there were floated logs in the coal, this would take us back to the formation of the coal by transportation. In every peat bog, the process of burying trees is in constant operation. The preservation of the logs which cannot be covered with water when they fall on the ground, is due to the agency of a moss, the *sphagnum* which extends its compact tufts always saturated with water like a sponge, over every fragment of wood, from the smallest to the largest. The *Sphagna* work like the ants to bury their treasures; and as their growth is continuous and stopped only by the frost, the heaping of their own woody matter which forms the *structureless* peat added to the wood which they have to preserve and the other plants of the marshes gives an appreciable thickness for each year. In the peat bogs of Switzerland, peat grows at the rate of two inches per year, a thickness reduced to one half by compression. In the same peat bogs, the *Sphagna* do not require more than three years to cover the stem of a tree of moderate thickness.

The bogs then, even the largest, enter naturally and without transportation into the composition of the coal as they become part of the matter of the peat bogs. In the deep bogs of New Jersey, there is a class of woodmen whom I would call log-fishers, who sound the marshes with long poles, to find the sound logs which they dig out of the black and already combustible mould or peat, from a depth of from six to ten feet. Some old swamps of Northern Europe contain as many as four or five generations of trees of different kinds imbedded from twenty to fifty feet deep and separated by thick beds of compact, entirely decomposed woody matter or peat. Some of those bogs are so abundantly filled with sound and large logs of oaks, pines and birches, that their removal has gone on for more than half a century before there was any material diminution of the supply, and for a long time it was supposed and even maintained that the trees of those marshes were growing under ground.

The flattening of all the stems found in the coal and in its shales, and also the layers of bark observed in the same formations, without any trace of internal woody structure, have also attracted a great deal of attention and useless theoretical discussion. In the oldest peat bogs of Germany, especially in the large swamps or lignite-deposits of the Pliocene of Saxony, the

trees are found all softened and already flattened to a greater or less extent. Some of the buried forests of England show the same appearance. From some clay banks exposed by a slide in the Jura mountains, large trees of recent species, still living in the country around, have been exhumed, and though the wood still preserves its natural appearance and its tissues, it has lost its hardness of texture and has become as soft as the clay itself. Hence, as Liebig has proved by direct experiments, in the process of slow decomposition or rather slow combustion in water, the woody matter is generally softened before its hardening and entire transformation in coal.

In Denmark, there are immense meadows, extending for miles along the shores and covering old deposits of peat or combustible matter to a depth of from six to eight feet. The entire mass consists of a half fluid paste with layers of the bark of alder and white birch, rolled, flattened or pressed like the leaves of a book. Farther back in the interior of the country, especially in the royal park of Copenhagen, the formation of this kind of peat can be followed in all its details. First a thicket of alders and birches sprout out, covering an overflowed surface of ground. The thicket is impenetrable, and soon presents a confusedness of stems and interlaced branches. Then, as the trees become older, the whole mass begins to decay, especially at the level of the water, and by and by it falls down by its own weight, becomes submerged in a few years, and from its own seeds upon the mould of its half floating, half decomposed remains, a new generation of trees appears again and the process of formation is continued in the same way. The internal woody matter of the trees, the lignine, is decomposed at first and reduced to a paste, while the bark, impregnated with resins, is preserved for an indefinite period. In the coal basin of Trevorton, Pa., there is a perpendicular wall presenting to the eye a beautiful picture of prints of Lepidodendra and Sigillariæ, crossing each other in every possible direction, all thin layers of bark superposed without any woody or carbonized matter between. It is nothing but the surface of an old coal-swamp, formed like the peat bogs described above. The peat which it covered has formed the coal, and the woody matter floating in water above it has been mixed with mud and formed the shales.

If it is true, as we said before, that all the peculiar accidents of the coal formations can be thus exemplified and explained by phenomena now observable in the growth of the peat, is it not surprising that the peat-bog theory of the formation of the coal should be still exposed to so many contradictions, and especially be subjected to continual and hypothetical modifications, which, destroying its simplicity, render it then truly unsustainable. The following reasons have been repeated time and again. The

repeated succession of various strata in the coal measures, viz., the constant alternation of fire clay containing roots of trees, with coal and shales, both containing remains of land plants or of marine shells; with limestone containing madrepores and shells of the deeper seas; with sandstone mostly without any fossil remains: this alternation evidently shows that at the time when the formation was progressing, the sea was continually brought in contact with the coal and covered it most of the time. Hence it follows; that if the coal has been formed in marshes like our peat bogs, we ought necessarily to admit of a submergence and therefore of a subsidence of the land after each deposit of woody matter, and of an upheaval of the same land to bring it up again above the level of the sea for each successive growth of a new peat bog. This appears to some geologists an unaccountable and unnecessary use of nature's internal forces; a kind of *lusus naturæ*, resembling a miracle. To meet this objection, they have supposed that the peat bogs of the coal measures grew on the deltas of some large river, and therefore exposed to periodical inundations: that as fast as the peat grew, the river brought upon it mud and sand, the materials from which the shales and the strata of sandstone were formed: that, nevertheless, the deltas being by some *internal force* constantly sinking, they were consequently sometimes invaded by the sea which covered their whole extent and in the course of time, built upon them the strata of limestone: that as soon as these strata reached the surface of the sea (a fact which probably supposes that the movement of subsidence had stopped for a while) the land plants began to appear again, the peat to grow, and the matter to be heaped up till another large periodical inundation of the river brought new deposits of mud and sand; and thus by continuous subsidence and repeated inundations, the coal, shales, sandstone and limestone strata were alternately formed.

Before giving any reasons in support of the alternation of upheaval and subsidence as supposed by the peat bog theory, we will take the liberty to examine this new theory which we regard only as a poor modification of part of the former which it assumes to put aside forever. It is generally asserted that in the coal measures, the alternation of strata is the same in the whole extent of a basin, or in other words, "*that each stratum is generally horizontally extended over the whole coal-field in a continuous sheet, so that each seam is accompanied by the same strata above and below.*" This is only partly true. In the coal-fields of the United States, it is true only of some beds of coal and of one or two strata above the conglomerates. Every practical geologist knows well that it is impossible to identify the position of a bed of coal by means of its adjoining strata. If the same strata

had been expanded without alteration through the whole extent of a coal basin, nothing would be easier than to fix at once the geological horizon of each bed of coal after the close study of a single section. The shales above the coal give by their fossils the only reliable data; but in many places they (the shales) are entirely wanting and are replaced by sandstone or limestone. In the western coal-fields of Kentucky, the first coal below the Mahoning sandstone, or the fourth coal above the conglomerates (the same as the Pomeroy coal of Ohio or the upper Freeport coal of Pennsylvania) whose shales sometimes reach in the East a thickness of 10 feet, is immediately covered by the sandstone. There is scarcely a vein of coal worked to any great extent, that does not show a great diversity in the thickness, density and color of its roof shales. Hence the necessity of roofing differently the tunnel of a mine in different places according to the nature of the shales. The bottom clay is almost always present; but its thickness, color and density are also variable. The limestone of the coal is the most irregular of all the formations. It is mostly local, sometimes only in boulders, and its numerous variations in thickness, composition and even fossils, cannot be accounted for by any satisfactory general rule. There is not in the United States a single bed of coal that is unvariably covered with limestone. The sandstone is generally extended with more regularity; but it has also its diversities of thickness and local disappearance. The only bed of sandstone which appears to be continuous in the whole extent of the coal-fields above the conglomerates, is the Mahoning sandstone. Though its thickness is also somewhat variable, it is found topping the 4th coal (coal E of Lesley's Manual) from the anthracite basin of Eastern Pennsylvania to the western extremity of the coal-fields of Illinois and Western Kentucky. The Anvil-rock sandstone, topping the 12th coal of Western Kentucky, though generally of great thickness, has not as yet been identified in the East. For the coal itself, the assertion of its continuity could be admitted as nearly true.

Though a coal bed cannot be called a continuous sheet in its horizontality, since all the strata of coal are subjected to thinning or even entirely disappearing in some places and some others are circumscribed in narrow limits, generally speaking, most of our large beds of coal can be traced through the whole extent of the coal-fields. The great mammoth vein divides itself into three or four different beds in some places, but is found continually, thinning from Carbondale to the western limits of the Illinois coal-fields. The first coal below the Mahoning sandstone (the Pomeroy coal) is seen to have the same extent with scarcely any change in its thickness. The Pittsburg coal which from its high position in the coal measures has been washed away over

large surfaces, shows itself, along with the characteristic fossils of its shales, in every part of the measures where the thickness is sufficient to reach to its level. Thus we have some beds of coal generally accompanied, at least locally, by their peculiar shales, and one great bed of sandstone covering a surface as wide as the whole extent of the Appalachian and the Illinois coal-fields, an area of nearly one hundred thousand square miles.

In a short report on the stratigraphical palæontology of the Geological Survey of Kentucky, or rather in an introduction to a future palæontological report of the Survey of that State, I expressed the opinion that the Appalachian and the Illinois coal-fields were once continuous fields, and that the great axis of the Devonian and Silurian measures which separate them now, had been elevated at an epoch posterior to the formation of the coal. This opinion was not and could not be discussed in a short local report. I could there only give in support of it the fact of the identical distribution of the coal beds and of the coal flora in both basins. As it has been very courteously controverted in this Journal,* and especially as the discussion of this geological point enters into our subject and may help to satisfy the mind upon the value of the so-called new theory mentioned above, it is proper that I should briefly present the reasons in favor of my opinion.

It would be absurd to assert that the veins of coal or rather that the peat bogs of the coal formations were formed on a perfectly horizontal surface, and that the woody matter was deposited in the same thickness over the entire area. The most even plains have undulations on their surface; and the cross-section given in my report of a part of the Dismal Swamp of Virginia, should have explained my meaning. The peat bogs of our time are more or less broken or crossed by small elevations of sand or hills of some other deposit, which here and there break their horizontality and also their uniformity of features. For, although these irregularities may be scarcely elevated above the surface of the bogs, they are without exception, covered with a vegetation of entirely a different character from that of the peat bogs, and therefore their outline is perfectly definite. Sometimes groups of islands are thus seen rising in the middle of the bogs. Sometimes, also, as in the granitic country of the Hartz mountains, or in the basaltic region of the Rhoen mountains of Germany, peaks of granite or columns of basalt protrude like towers from some parts of the swamp. No one will contend that these irregularities break the continuity of a formation; or that the peat bogs on both sides of a hill of sand or around a block of granite are not a *continuous formation.* In a geological point of view, accidents like these cannot be taken into consideration.

* This Journal, vol. xxvi, p. 78, July, 1858.

But it is clear, at least to my mind, that the great ridge of Devonian and Silurian by which the Appalachian and the Illinois coal-fields are separated to a distance of from one to two hundred miles, cannot be regarded simply as one of those hills which separates two parts of a peat bog. We can discuss only these two alternatives: either the Silurian axis was not upraised at the epoch of the formation of the coal, and this formation, being in active progress upon the whole surface occupied now by the coal-fields and the Silurian and Devonian, was *continuous*, and consequently presented the same general features; or, the coal was formed on both sides of the ridge, and therefore in two separate basins, and then both formations, though of the same age, would have been subjected to some peculiar influences, and each of them would be characterized by some differences, either in the relative position of their coal beds, or in the composition of the strata, and especially in the distribution of their flora. The report of the Kentucky Survey shows on the contrary: that in both coal-fields, the coal beds are exactly in the same relative position; that at the same geological level, their shales contain the same species of plants; that from Eastern Pennsylvania to Western Illinois, the thinning of some strata preserves a perfectly regular progression, and does not show any change on one or the other side of the great ridge.

But there are some other reasons which may appear more conclusive.

1. The conglomerates, as also some beds of sandstone, especially the great Mahoning sandstone, are developed near the eastern limits of the coal-fields to a prodigious thickness. This heaping of loose materials, sand or gravel, evidently shows the prolonged action of the sea against its shores. Supposing that the Silurian ridge had been elevated before the formation of the coal, it would have necessarily served as a shore, and we should find somewhere a marked difference in the thickness of the transported materials abutting against it. No geologist has ever seen anything of the kind, and the conglomerates like some beds of coal and of sandstone, go thinning to the west with a constant and uniform decrease.

2. All the peat bogs are formed in basins, as also all the deposits of coal, and the outlines of these basins are of course generally broken and irregular. This fact is observable in the eastern and southern borders of the coal-fields. But on the sides of the coal-fields lying opposite each other along the great axis that separates them, the outline is well defined and unbroken.

3. In a basin where many beds of coal have been successively formed and separated by different strata, some of the upper coal beds must necessarily abut against the walls of the basin, when they are found in their horizontal position. In other words,

by the outward direction of the wall of a basin an upper bed ought to be extended somewhat beyond the lower and cover its margin. It is the case in the western borders of the Kentucky coal-fields, viz. in Christian county and other places, where the 4th coal above the conglomerate or the next bed below it, abuts against the older formation, when the lowest coal has to be looked for farther back towards the centre of the basin. On both the opposite sides of the Appalachian and the Illinois coal-fields, the appearances are different. It is the lowest coal, then the conglomerate, then the sub-carboniferous strata that appear one after the other upon the surface, following a dip corresponding to that of the sides. This undoubtedly shows that they participated in the movement which elevated the ridge that divides them, and that they were formed before its upheaval.

4. The undulations of the surface of the coal-fields, so distinctly marked in the vicinity of the Alleghany mountains that by lateral compression the veins of coal have been upraised in a perpendicular and even in a reversed position, are constantly repeated, though constantly less frequent and abrupt elevations westward. The upheaval of the Silurian ridge appears like one of those undulations, being generally in a direction parallel to the others.

5. The upheaval of the Alleghany mountains and the undulating movement caused by it upon an immense surface of country was very slow, and continued for a long period. The bends or flexures of the eastern coal, especially of the anthracite coal-fields are not jagged and angular, nor are they often broken by faults. The shales are polished by sliding, and rolled as if they had been folded in a soft state. The coal itself presents the same appearance, and at the bottom of the flexures, it is generally, as the miners well know, somewhat thicker than on the raised sides, as if the matter had slipped by its own weight when there was room for a displacement. Hence, it follows that if the undulating movement was slow, and if the strata of the coal measures were still in a soft state and easily removable, the top of the great ridge was necessarily and easily washed away as fast as it was being raised near and above the surface of the sea. No wonder therefore that the remains of the coal strata have not been preserved, and that we scarcely find any trace of them. The total disappearance of the coal washed away by erosion, is, I think, the only objection of any weight that has been or may be made against the opinion advanced in these remarks. But there are in Pennsylvania, in Ohio, and everywhere in the coal basins of the United States, evident traces of vast denudation that may be compared with the washing away of the Silurian ridge, and of which no trace has been left in the subsequent strata of this country.

It would be easy to multiply these considerations and to sustain the position by a number of geological facts. But so much is sufficient for our purpose, and we come back to the question of the formation of the coal. Upon the supposition then that at the time of the coal formations, the Appalachian and the Illinois coal-fields were united in one area, their surface would fairly be estimated at 300,000 square miles. Now, in the new theory presented above, we find it asserted: that the shales and the sandstone of the coal have been deposited upon the surface of the peat bogs of the coal formations by the inundations of some large river! Would it be possible for a sound mind to admit that a river can cover at once or even by repeated inundations, a surface of three hundred thousand square miles with a deposit of sand from six to one hundred feet thick, which is the thickness of the Mahoning sandstone.

Giving to the hypothesis the widest range of probability and considering as a peculiar Delta the area (sixty thousand miles) of the Appalachian coal-fields, still we find no geological phenomena of our time to justify it. Let us compare a few data. The whole plain of the Mississippi, comprising the Delta, from Cape Girardeau, 50 miles above the junction of the Ohio to the sea, covers an area of about 30,000 square miles. Would it be possible to suppose that an inundation would ever cover this whole surface with only a few feet of sand or of mud? According to the observations mentioned by Forshey, the mud transported in one year by the Mississippi river would cover a surface of twelve square miles with one foot of alluvium. At this rate it would take five thousand years for a river as mighty as the Mississippi to cover a single bed of the Appalachian coal-fields with one foot of shales.

Moreover, it is well known that a river cannot spread any of its transported material in a uniform manner, especially not in the deltas which are exposed to continual changes. For a delta is never composed of compact materials. It is mostly cut by variable and sometimes under currents covered only by a crust of vegetation, sustained by drift wood or floating upon the deep and muddy waters. These currents cause constant alterations: extensive marshes sink and are buried to a great depth below the general level of the country; lakes appear in some places and dry up in others; some bayous are filled and others opened. There are few square miles around New Orleans and on the Mississippi delta, that have not been thus subjected to violent disturbances, whose effects will be traced for ages in the most varied and disordered position of materials or stratification, if it can be so called. On the contrary, the stratification of the coal measures is of the most regular kind. The homogeneousness of the strata superimposed on the coal, especially the shales, shows

the total absence of a current at the time of the deposition of the matter. Not only the most delicate parts of the leaves of ferns are preserved in the shales, just as they fell from their supports; but we generally find around the same spot the remains of the same species. A kind of fern of which the deciduous leaflets are generally found separated from the stems (*Dictyopteris obliqua*, Bunb.), in some places completely covers the shales over a surface of from six to ten square feet, and without this space, not a single leaflet of the same species is found. It is evident therefore that the leaves have been buried at the place where the ferns grew and as they were falling from the stems. The slightest current would have made of all the matter a disordered mass in which leaves of every kind would have been mixed, not only in every position, but without regard to the place of their growth.

It is impossible to account for the successive deposits of shales and of sandstone by a river. When an inundation is at its height, it bears with it the heavier materials and these are deposited just as the current subsides. The sand would therefore be deposited before the mud or the sandstone formed below the shales and not above it.

But the deposits of all our great rivers, the Mississippi, the Ganges, the Amazon, the Po, is mud only. Sand is occasionally transported by a river or removed from one place to another by some strong current, but then it constitutes a bank and is generally a local formation of small extent.

All the great deposits of sand in our time, which by their thickness and extent, may give an idea of those which have covered the bogs of the period of the coal, are marine formations. The drift of North America and Northern Europe, our Pine-barrens of the south along the shores of the Atlantic; the pampas of South America, the heaths of Luneburg or sand plains along the southern shores of the Baltic Sea; the sand hills of Eastern Germany and Holland along the shores of the North Sea; the downs of the Gironde and of the Camargue in France; the sandy deserts of Syria, &c. No one of these formations can be referred to the direct agency of a river.

That the sandstone of the coal generally contains no remains of marine animals, does not prove that it is not of marine origin. The sand of our drift scarcely contains any of them. The hills of sand along the shores of the Baltic and the North Sea are almost entirely destitute of shells and animal remains. Sand is not only permeable to the all decomposing oxygen of the atmosphere, but it is a grinding agent, and as it is put in constant motion, either by the waves and currents of the sea, or by the wind, it is not to be supposed that even the shells would be long preserved in the loose materials. Yet in some places, the sandstone of the coal, especially when it is fine and soft, has

preserved the casts of marine shells, though not the remains. I have found them in many places, especially near Athens, Ohio, where a bank of soft sandstone is full of large *Producti* and *Terebratulæ.* But here, as in the sandstone of the lower measures, the animal remains have disappeared, and the mould only is preserved. It is the same with the prints of fossil wood found in the sandstone, which only shows the casts of Lepidodendra, Calamites, Sigillariæ, &c.; with only a thin lamina of carbonized bark, the whole substance of the wood having disappeared, except where silicification has taken place. This shows why the fossil remains are so rare in the sandstone, since even a cast can scarcely be made on loose sand.

In the shales of some beds of coal, especially in the southwestern part of our coal-fields, the remains of marine shells abound: some of the species are supposed to have lived in brackish water; but most of them like the fishes found in connection with them, appear to be true marine species. And what at first may look like an anomaly which will be explained hereafter, these marine remains are sometimes more or less mixed with leaves of ferns or land plants, and scarcely if ever with true marine plants or Fucoids. Thus, also, from palæontological evidence, the shales cannot be considered as deposits of a river any more than the sandstone.

The fact that the limestone of the coal measures cannot be thus disposed of, is fatal to this new theory. Its marine origin is evident and must be accounted for. And as the ocean cannot be swollen, like a river, it is necessasy to admit of a subsidence of the land for its submersion in the sea. But the supposition of a continual subsidence of a vast country is truly as violent an hypothesis as the supposition of an alternation of upheavals and subsidences of the same country, and the difficulty to account for the first proposition is far greater. Geological forces are not acting forever in the same way. It is now generally acknowledged that mountains have not been upraised in a single movement, but by a succession of gradual efforts, or by epochs of upheaval succeeded by epochs of rest, and consequently of subsidence; since a diminution in the activity of the internal forces cannot but cause a depression by the natural resistance or the weight of the upraised masses. We find proofs of such alternate changes of level at the present time; the movements of the ground about the temple of Serapis, so clearly explained by Lyell; the appearance and disappearance of some islands, &c., and especially in the stratification of our recent formations. The coal of the Miocene epoch was also formed by peat bogs upon an upraised land. The shales contain leaves of different species of trees of which the congeners are found in tropical regions. These shales are covered by successive strata of conglomerate, sand-

stone, and limestone. The coal and the lignite of the Pliocene epoch have been formed in the same way. Their shales contain remains of land plants, and sometimes also they are alternately covered by sandstone and limestone. The drift which is extended over the whole is as evident a marine formation as the limestone itself, and now it is in some places more than seven hundred feet above the level of the ocean. Is not this succession of land, freshwater and marine formations, in perfect accordance with the alternations of the strata of the coal measures, and can it be explained in any other manner than by the oscillation, the upheaval and subsidence of the land which supports these formations?

Even if the theory of continual subsidence could find in recent phenomena anything favorable to its support, it would be impossible to understand how a long protracted downward movement, especially of a Delta, would effect the repeated formation of coal beds; how the land being completely covered by the sea for the formation of the limestone, could be dried up again, so that the formation of the peat could begin anew, upon its whole surface. The river, says the theory, was still filling up again the whole space, while the madrepores were building the limestone. But this is pure speculation which is equally contrary to reason and to geological facts. For, if it is true that from causes which have not yet been clearly explained, the delta of the Mississippi is slowly subsiding, it is probable that if the subsidence was once active enough to permit the invasion of the sea over its whole surface, the soft matter, sand, mud and peat, of which it is composed, would be washed away by the marine currents, the tides, the waves, &c.

In the Report of the Geological Survey of Kentucky, I expressed an opinion which does not now perfectly satisfy my mind. I supposed that after the formation of extensive peat bogs, the subsidence of the land being at first very slow, the first result of the downward movement was a general inundation either of marine or of freshwater or of both mixed together. A depression of only a few feet of the great swamps of Southern Virginia would bring upon them by-and-by the waters of the surrounding rivers and also some water from the sea, either percolating through the sand or finding its way by some friths between the hills of sand extended along the shores. This supposition fully explains the formation of shales covered in some places with marine shells and remains of fishes mixed with land plants of the peat bogs. For, these plants, especially the ferns, mostly growing upon the thick and high rootstocks could still live in the swamps invaded by marine water. It explains also the local formation of the limestone in some depression of the marshes or marine lakes. But I supposed that after this period

of slow subsidence, the downward movement becoming more rapid, the sea broke through its sandy barriers and swept at once upon the whole plain, bringing with it the sand of its shores for the formation of the sandstone. I do not find this last supposition necessary. For, even with a slow movement of subsidence, continuous for a while, the sea ought to penetrate to the interior of the land, and with its continuous encroachments, bring forward with it the sand of its shores. This would better explain why some strata of coal and sandstone are thicker westward, where the bogs grew for a longer time and where the action of the sea was afterwards prolonged. It explains, also, why to the westward some veins of coal are double and generally more numerous than to the southeastern part of our coal-fields, this multiplication being caused by partial retrocession and advance of the marine element, which was felt only near the inside of the coal-fields and did not reach the deeper outside borders of the original basin. But there is no material difference between these explanations. In either case the repeated upheaval of the sea-covered land is supposed as a necessary condition of the formation of the peat; for this matter can grow only upon land where the water of the sea cannot reach.

To this last assertion which has not been contradicted, we can add the following: that peat never grows on swamps that are annually or periodically flooded by river water. Examining the swamps of the Mississippi, the theory says, that though covered annually by inundations, they are entirely untouched by river mud: that those favored spots are surrounded, particularly on the side next the river, by dense vegetation, which acting as a sieve, completely strains the mud from the water before it reaches the peat swamps. The water of these swamps is therefore pure, and pure peat has been deposited there for ages. Contrary to this authority, I must be permitted to say that during about thirty years of explorations in the peat bogs of Europe and of the United States, I have never seen the peat growing in places exposed to the inundations of a river. On this subject, there is better authority than my own. De Luc, in the beginning of this century, was the first to remark that along the banks of some rivers, the Elbe, for example, there were formed extensive beds of peat, which appeared to be lower than the water level of the river at the time of its inundations, and that nevertheless they were not covered by water, but by a peculiar vegetation which by its decomposition furnished the essential constituent of peat. In the prosecution of his researches, he observed that along these bogs the bed of the river was bordered by a natural embankment, which even in the highest rise of water prevented it from reaching the peat bogs. This damming up was fully explained by his remark: that at the time of the inundations and

when the water was most loaded with sediment, the heaviest particles of muddy matter were deposited all along on both sides of the river, just where the current began to lose its force; and that by this process, continued for a long period of years, a natural dam being built along some rivers, the marshes on both sides of it, and formerly inundated, were eventually put out of reach of the inundations. I have myself ascertained that the thin particles of sediment which were at first deposited upon the marshes, formed an essential preparation for the growth of the peat, viz. an impermeable basin, and that it was only when this basin was entirely isolated and protected against inundation that the plants of the peat bogs began to appear and the peat to grow. This process explains the formation of the fire-clay which underlies every bed of coal.

The true peat bogs of the Mississippi delta are mostly located on or near the old shores of some crooked bayou and surrounded on all sides by a kind of embankment. Thus they are free from the influence of river water which, though clear, would stop the growth of the peat, by destroying the peculiar vegetation of the bogs.

The action of the water in building its own banks along the principal bed of a river is beautifully exemplified in the United States, especially along the Mississippi and some of its tributaries. Both sides of the Minnesota river are thus bordered by extensive marshes which cover the bottom land to the base of the ridge of the prairies. In spring they are filled with water, while the banks of both sides of the narrow channel are mostly dry still high above water. It is then very difficult to cross those marshes from the river to the prairies or to land from a steamboat. Seen from the top of some hill near by, the Minnesota then appears like three different rivers running parallel and separated only by two narrow strips of land overgrown with trees. In the summer time, the marshes are mostly dry, overgrown with sedge and some willows; but no peat bogs have till now appeared in any part of their whole extent, because the separation from the river is not yet complete and because they are still exposed to annual inundations. In Minnesota, the peat bogs are found upon the prairies, near or around lakes without outlets, and on the banks of the upper Mississippi under the same circumstances as on the lower, viz. in such places as are beyond the reach of inundations. We may have occasion to extend these remarks farther when we come to consider the nature of the vegetation of the peat bogs.

In spring, at the time of our periodical inundations, the plants growing on the marshes of the Mississippi and along its shores are mostly lying flat upon the ground in a state of partial decomposition. The high canes only (Arundinaria) rise above water. And as they mostly bear their branches and leaves near

the top of the stems, or above water, these stems can not help much in the process of purifying the muddy water. Yet it is true that it becomes clear towards the interior of the marshes, but only as fast as the current becomes insensible or the water still.

Mr. Lyell has been quoted as authority for many assertions for which he can scarcely be held accountable, or at least for the conclusions which are drawn from them. Thus the *new* theory of the formation of the coal tries to find support in a geological assertion of the celebrated English author, an assertion that I do not recollect to have read in any of Lyell's works and which would truly show too much of ignorance of the palæontology and even of the strata of the coal measures. It is this: "In the sandstone of the coal formations, it is customary to find trunks of trees, but only trees, no small branches, leaves or tender parts. And these trunks are observed to be mostly pines, highland trees, while the trunks of the coal seams proper are Sigillariæ, Lepidodendra, Calamites, swamp trees, &c." From this, the new theory concludes: that the trunks are the remains of drift timber brought by the river from the high lands.—As if the sea could not and did not float timber as well as a river!

But it is not with the conclusion that we have to deal now, but with the assertion, erroneous in every point.

1. The trunks of trees are by far more rarely found in the sandstone of the coal than the small fragments of leaves, branches, &c. Some strata of sandstone, the Mahoning sandstone and others of the low coal measures, are sometimes entirely blackened by those small fragments of plants so bruised that it is scarcely possible to identify any species. This is not a local appearance; but it is observable in the whole extent of the coal-fields generally on the same stratum of sandstone. This shows a rapid movement of the sea, which sweeping with impetuosity upon the peat bogs of the coal, washed away part of the decomposed plants and peat bogs and mixed them with the sand.

2. Representative species of the Pine family have scarcely been found in the true coal measures. In the family of the *Cupressineæ* which has more than sixty species of fossil plants distributed in twenty genera, there is not a single species belonging to the coal epoch. In the family of the *Pines* which has at least one hundred and fifty fossil species known, distributed in twelve genera, there are only thirteen species which have been referred to the true coal measures. Two of these, *Peuce Hugeliana* Ung. and *Peuce australis* Ung., belong to uncertain formations of coal of Van Diemen and Vanguroë Islands. Of two other species, one, *Dadoxylum Beinertianum* (Endl.) belongs to the limestone (not to the sandstone of the transition epoch), the other *Dadoxylum Sternbergii* Endl. was wrongly ascribed to the coal and be-

longs to the Miocene of Haering in Tyrol. A fifth species, *Pinus anthracina* Ll. and Hutt., is a cone which was found in the *shales* of England. There are then only eight species of the pine family which have been found in England, in a bed of sandstone referred to the upper coal measures and described by Witham.

Admitting the position of this sandstone as true, though it is most remarkable that the remains of the Pine family should have been found in the coal measures of England only, there has been found in the sandstone of the coal measures 4 species of *Stigmaria*, 15 species of *Sigillaria*, 10 species of *Lepidodendron*, 3 of *Knorria*, 4 of *Halonia*, 6 of *Calamites*, 10 to 20 species of *Psaronius* and other stems. This would make at least 60 species outside of the Pine family for 8 in it. The same proportion would be true according to the number of specimens. In the state of Ohio, near Athens, there is perhaps the most extensive deposit of transported silicified trunks that it is possible to find anywhere. Of some thousand specimens that I have examined, all belong to the genera *Sigillaria* and *Psaronius*. A single specimen which is not yet determined has concentric circles, and may belong to the genus *Araucaria*.

From recent observations, it appears that the genus *Sigillaria* is related to the *Isoetes* of our time, a water plant. All the *Psaronii* are trunks of ferns and like the other genera quoted above, they all belong to the flora of the true coal formations, and are found in the shales also. Nevertheless, this does not put aside that part of the assertion: that some trees of the sandstone might have been transported from a dry land. It is a complicated question which may be examined at another time.

(*To be continued.*)

ART. IV.—*Some Remarks upon the use of the Microscope, as recently improved, in the investigation of the minute organization of Living Bodies;* by H. JAMES CLARK, of Cambridge, Mass.

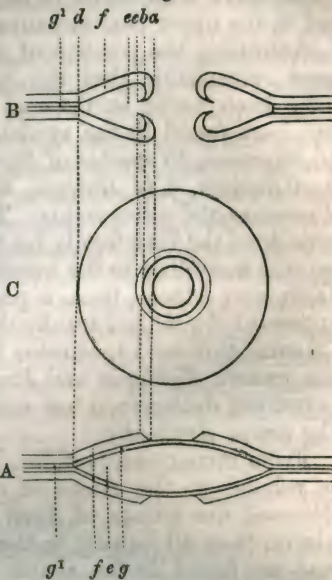
[From the Proceedings of the American Academy of Arts and Sciences, Boston, Mass., January 26, 1859.]

I WAS incited to bring together my thoughts and experiences upon this subject, by discovering, three or four months ago, a novel feature in the so-called glandular dots of the wood of our common White Pine (*Pinus Strobus*, Linn.).

A dot of this kind is usually represented by a circle (fig. 1, C, *d*), in the centre of which is a single or double ring (*a*, *b*), which has about one third the diameter of the first (*d*). The outer circle (*d*) is described as the boundary of a lenticular space (A, *e*) between two *contiguous cells*, and the inner double circle (C, *a*, *b*) as the outskirts of a perforation (A, *a b*) in the deposit layer (*f*)

of the cell. The double circle arises, as is said, from the fact that the perforation has the shape of an extremely short truncate cone, which, when viewed endwise, presents to the eye its two circular ends concentrically; the broader end, which is always next the interior of the cell, corresponding to the outer (*b*), and the narrower end to the inner circle (*a*). Thus are these dots described and illustrated, by Mohl, Schleiden, and Schacht, as seen in the common European Pine (*Pinus sylvestris*), and thus did they always appear to me, not only in that species, but also when I observed them in *Pinus Strobus*, except with this difference, that the perforation was bounded by an exceedingly faint third circle, (C, *c*,) whose relations I could not comprehend, nor was I able to reconcile its presence with the theory in regard to the nature of the perforation. I therefore left it, doubtingly supposing it to be some optical illusion. The microscope which I used, and which I have been in the habit of using up to within the last six months, is an Oberhaeuser's, made for Prof. Agassiz some years ago; and yet at this very day I find it as good, with perhaps a single exception, as any now made in Germany, and therefore just as trustworthy in the investigation of the glandular dots of the Pine.*

Fig. 1.



* It may not be uninteresting to state here, that the first great microscope made in Germany was constructed in 1829 by Fraunhofer, for Professor Agassiz. This microscope was represented in a copper-plate engraving, and described by Döllinger in the Memoirs of the Munich Academy for 1829, or 1830. In January, 1831, Agassiz went to Paris, and having given unlimited orders to Oberhaeuser for the best microscope that could be furnished, according to the knowledge of those times, he received from that maker, in 1832, an instrument which has not been surpassed in all Germany to this very day; at least, I have never seen any work from the hands of the best observers there, whether zoologists, histologists, physiologists, or botanists, which could not have been accomplished just as well by this microscope. There may be one exception to this of a very recent date, but I am acquainted with the instrument only through report. With this masterpiece of Oberhaeuser, Agassiz has gone on to this time, doing his great work with remarkable success, as all the world knows. Of late years it has become evident to Agassiz that his instrument was not equal to the demands which the progress of his researches put upon it; that there was something beyond its reach, of which he now and then could get a glimpse, just enough to warrant him in the belief that the study of the intimate structure of organized bodies had hardly begun.

So long ago as 1852 he had opportunities to see the workings of an instrument of the English pattern, made by Spencer; and although it was known as a rival of, if

For the last six months I have used one of the most recently improved microscopes, made by Mr. Charles A. Spencer of Canastota, N. Y.; and with this, between three and four months ago, I again attempted to solve the mystery of the glandular dots. This I did with the most complete success.

When the focus was brought to bear upon the inner surface of the dot, the innermost ring (B, C, *a*) of the perforation appeared first; a little deeper, the next outer one (*b*) came into view, whilst the innermost (*a*) disappeared; and still deeper the last (*b*) passed from my sight, and the faint ring (*c*) of my old observations came out sharply and clearly, as an exterior circle to the two others.

I also observed, when passing from the innermost circle (*a*) to the outermost (*c*), that the widening was gradual; and so, too, did it appear in the transit from the second ring (*b*) to the outermost (*c*). This gave me the clew to the whole structure. I saw that these rings were not the expression of a simple perforation, but of the outwardly curled edge of this aperture, shaped in such a way as to form a sort of trumpet mouth.

Although I would not trust to a transverse section alone, yet I found that it confirmed me in my views as explained above. The figures which I have given,—namely, a transverse section (B) with dotted lines projected upon a face view (C) of the dot,—I think will suffice to illustrate what I believe to be the true relations of these rings.

Now, why was it that the Oberhaeuser instrument would not divulge these relations, when the microscope of Spencer succeeded so satisfactorily? This I will explain by showing the difference between the objectives of the two microscopes. I will compare the action of the objective of Oberhaeuser to the manner

not superior to the Transatlantic microscopes, he did not become convinced that it came up to his requirements.

Two or three years later I had the pleasure of bringing to his notice the results of some of my own researches upon the value of recently constructed objectives of English make. This gave him renewed hope, and, having heard of Spencer's continued rivalship and growing superiority, he determined to test his skill to the utmost. He therefore, in 1857, requested me to visit Canastota, in order to consult Spencer, and advise him as to the nature of the work for which we wished to use his instrumeuts. This consultation resulted in the conclusion that we must have three sets of objectives;—one with the extremely flat field; a second of the like kind, but so put together as to allow working with it plunged in water; and the third with a depthing focus extending as far as possible beyond that of the ordinary kind, for the purpose of viewing objects as a whole, in order to ascertain the relations of their different parts. And Spencer is now devoting those extraordinary abilities which show him to be a man of genius, to the construction of a microscope which shall embody not only the optical excellences of the different systems of lenses required for the various modes of investigation, but also those conveniences of mounting which the long use of that instrument has taught us, to facilitate the researches upon the living being in its normal condition, and in its element, that we may be no longer compelled to represent the tortured figures of a crushed body or dismembered organism.

in which a plano-convex lens treats the rays of light which pass through it, from any object. Those rays which pass near its axis are brought to a focus at the farthermost possible point from the lens, whilst the rays which pass through the periphery are converged at a much nearer point, and between the axis and periphery there are all degrees of convergence. The difference between the farthermost and nearest points of convergence may represent the distance or depth through which the objective takes cognizance of things, and will account for the fact that I saw all the rings of the Pine-dot at one time.

The action of the objective of Spencer's microscope may be compared to that of a parabolic lens, which converges all the rays of light to one absolute plane, and therefore forms what is called a *flat field.*

Now out of this field, either above or below its horizon, it is not possible to see anything, and on this account, when the innermost ring (B, C, *a*) of the dot was in view, the others were not to be observed; and when the field was lowered to the second ring (*b*), the innermost one (*a*), being above the horizon of the field, was invisible; and, again, when the outermost and lowest ring (*c*) was reached, the middle one (*b*) also vanished.

Were this outermost ring as distinct as the others, it might have been possible to detect its relations by means of the Oberhaeuser; but since it is the exceedingly delicate, reverted edge of the perforation, the narrow aperture of this ordinary objective does not admit sufficiently oblique rays to define it, to say nothing of its being confused with the other rings which are in view at the same time.

I would here remark that this peculiar structure is most frequently to be observed in old wood, when the cell-wall (B, g^1) has also become perforated, and even has retreated from the deposit layer as far back as the edge of the lenticular interspace. In young wood the perforation corresponds with the figures usually given. I have used this discovery, not only to show how little may be understood of the structure of a familiar and much treated of body, but also as a preliminary illustration of the exceeding value of a flat field and a wide angle of aperture in microscopic investigations.

But this is not the first example which has occurred to me. As far back as a year ago last summer I visited Mr. Spencer, and spent several days with him in testing his objectives with the tissues of every creature which we could find. I shall never forget the astonishment and delight with which I occupied day after day, plunged into the hitherto unknown depths of organic life. I say this after having tested from time to time some of the best English microscopes which have been made since the "Great Exhibition," and therefore am not to be supposed to

have made so great a leap as if from an Oberhaeuser to a Spencer. Since that visit, and another one also, made last summer, when I obtained one of Mr. Spencer's quarter-inch objectives, with an angular aperture of one hundred and forty-five degrees, I have from time to time made particular efforts to test the value of the flat field and wide angle in the study of organized bodies. The results of my investigations at Canastota, and also since my return, I have embodied in this paper.

One of the most valuable properties of the flat field is, that it enables one to study an isolated cell, in a manner totally unexpected to me, making it possible to obtain a section of such a body at any horizon, as if it were actually cut across. As I have said before, the flat field ignores everything above and below its horizon, and therefore, if it is brought on a level with the equator of a spherical cell, the largest possible circle is obtained, and the actual thickness of the wall becomes apparent; and if it is raised or lowered, the circle grows smaller and the wall seems thicker, because of the obliquity of the section, and yet appears as distinct as the one at the equator. This may go on until the field approaches very closely to the upper or lower side, and then the inner surface of the cell appears. In an ordinary microscope, the far-reaching power of the objective utterly precludes the possibility of such a process of investigation.

The relations of the Purkinjean vesicle to the yolk, and the number and position of the Wagnerian vesicles, have always been difficult subjects to work out with the ordinary microscope. If the Wagnerian vesicle was situated at the upper or lower side of the Purkinjean vesicle, it has often been next to impossible to tell whether it might be really within the latter, or was one of the very similar yolk-cells outside. There are many other instances of the like kind too numerous to mention. All this difficulty I have seen obviated by the decided, section-like precision of the flat field, which at once revealed to the eye the exact and relative level of every vesicle or yolk-cell.

I was most forcibly reminded, not long ago, of the value of the wide angle of aperture, and the accompanying great amount of light, upon trying Spencer's objective upon the stem of a well-known Hydroid, the *Clava leptostyla,* Ag. In the manuscript of the forthcoming volume of Professor Agassiz's "Contributions to the Natural History of the United States of America," the outer wall of this Hydroid, and of several others, I may say in passing, had been described as a structureless membrane; but what was my surprise, in my last attempt, to find that this wall was composed of a layer of polygonal cells, as distinct as any in the other parts of the animal, and even readily discernible in the more opaque parts, where the stem appeared like a simple black surface under the ordinary microscope.

In regard to the usually estimated worth of wide angles of aperture, I would say, that, from numerous experiments upon living tissues, objectives having this property are valuable, not so much because they can admit extremely oblique one-sided rays, but because they allow rays to enter from all sides at a very wide angle to the axis. One-sided oblique rays throw the shadow in a great measure, beyond any particular cell upon its neighbor, and this produces distortion; whereas when the rays converge at a wide angle, each cell becomes strongly marked at its periphery by a dark, broad shade. A moderately oblique, one-sided light, hardly twenty degrees from the axis of the objective, always appeared to be the most frequently serviceable. I was surprised one day to find that the hitherto faintly visible circulation in the cells of Spirogyra was rendered, by such a light, very distinct, and the granules borne along in the current appeared like little specks with a very sharp, thick, black outline.

At first thought, there would appear to be an insuperable objection to the wide angle of such objectives, and that is the shortness of the working distance, which will not allow one to take anything more than a superficial view of a body, even of moderate thickness. But this objection has not the least force, and, on the contrary, the more nearly absolutely flat the field is, especially in the lower powers, such as the $\frac{1}{2}$, $\frac{2}{3}$, and 1 inch, the better will they bear the use of the higher eye-pieces. This is not a speculative suggestion, for I have been told by Mr. Spencer, that he has been able to see the lines upon *Pleurosigma angulata*, with a one-inch objective of his make. Now nothing but the enormously wide angle and the remarkably flat field which he has introduced in such a low power, could enable one to solve such a finely marked Diatom. Only a few years ago this little unicellular plant was a test object for the highest powers of the best microscopes.

But if this image, or the image of any minute body, is to be magnified to any extent which may be required, by the use of the higher eye-pieces, the latter must be most exquisitely corrected, as regards their spherical and chromatic aberration, or else everything comes to the eye in a distorted state. On this account the Huyghenian ocular is not fit to be used, since it lacks just what we need here. I have for several years past asserted that the next step in the increase of the magnifying powers of the microscope would be accomplished by the construction of a new form of eye-piece, which would augment the image formed by the objective to an almost unlimited extent. At last I am happy to find my prediction verified, in the most practical manner, by the "orthoscopic ocular" invented by Spencer. With such a range of powers, then, there is hardly any body of moderate transparency, but what may be minutely investigated to its

very core. If a subject is too thick for the short working distance of the higher powers, a lower objective may be used, and the higher oculars applied to make up the deficiency. Of course I do not mean to say that a certain amplification obtained by a low objective and a high orthoscopic ocular is fully as good as the same afforded by a higher objective; but in case the latter cannot reach a certain internal structure, the former can be used, with very little appreciable difference, and is by far better than the usual methods employed in such cases, such as pressure or dissections and the isolation of the organ to be investigated.

I have not had an opportunity to make frequent use of the "orthoscopic eye-piece;" but Mr. Spencer has furnished me with another form of ocular, the "solid eye-piece," invented by his pupil, Mr. Tolls. This, Mr. Spencer tells me, so closely approaches the "orthoscopic eye-piece" in quality, that none but a very experienced eye could detect the difference, and the former excels the latter in the admission of light, because it has fewer reflecting surfaces. With this ocular and a quarter-inch objective I have run the magnifying power up to two thousand diameters, with wonderful results which fully justify me in saying all that I have in regard to the study of thick tissues with low powers having wide angles of aperture.*

I will take a young fish as an example to illustrate the remarkable efficiency of the flat field. In a view from above, one may see no less than six or seven different layers or sets of organs resting one over the other; first the skin and the muscular layer, next the vertebræ, within these the spinal marrow, and below the latter the chorda dorsalis, and close to this the dorsal artery, then the intestines and their appendages; and yet every one of these may be plunged through and totally ignored, on account of the peculiar properties of the flat field, and the last, the intestines, minutely inspected, not only cell by cell, but each cell may be studied, in every particular of detail, as if it were isolated. And so may any set of organs be treated, whether situated above or below in the animal. With such means at hand, as long as cells may be seen with a very moderate light, it is utterly preposterous to trust what may be worked out by separating these organs from the animal, piecemeal. When intact, every cell may be measured, not only transversely, but also with the greatest nicety in a perpendicular direction, by the

* In this connection I would urge upon students the necessity of avoiding the higher powers of the microscope in the commencement of their studies. When they have learned to use the lower objectives, it will be a much easier matter to master the higher ones. Students usually suppose that they can see everything with the higher powers, whereas they are greatly mistaken; as much as one would be who should make a minute inspection of the stones of some great architectural pile, and then think he had obtained a proper conception of its magnificent plan and glorious proportions.

micrometer screw, which works the fine adjustment of the objective; every cell, indeed, may be treated as if it were a separate body; but who would warrant to measure, for instance, the size of the cells of a nerve after it had been removed from its natural position, and with more or less inevitable distortion? Unfortunately, investigators have been compelled to do this too often, up to this very day; but now I hope for much better and more trustworthy results.

In embryology, how beautifully this almost transcendental definition of the objective applies! All the cells of an embryo of a certain age may be represented by a circle, with a smaller circle within known as the mesoblast (nucleus). At successively later ages we find the cells of the nerves, for instance, simply oval, as the first step to elongation; next they are in rows; then the ends in contact are without walls, so that each cell opens into its neighbor; and finally, all trace of the separate cell-wall is lost in the straight sides of the nerve tubule, with nothing but the mesoblasts to indicate the original position of the cells. In the chorda dorsalis, intestines, vertebræ, muscles, &c., similar and apparently gradual changes have been observed; but each step, in most instances, was investigated isolately from the previous one, and the intervening space bridged over by the process of inductive reasoning alone. This is not enough; now we know that every second of the life of a cell, or series of cells, may be traced most minutely, minute by minute, hour by hour, and day by day. Day and night, watches have been kept by observers in other departments of science, and why may not the naturalist do so? In some cases a very extensive series of changes may be observed in a short time; for instance, in the embryo of the common Bream (*Pomotis vulgaris*), which Prof. Wyman has observed to pass from the segmenting of the yolk to hatching in the space of about forty hours. It is not possible, in any way, to trace the gradual metamorphoses of cells and organs, except upon the living body; otherwise, every observation is a record of a detached fact, and no more; every bit of an organ is subjected to all sorts of manipulations to bring out what too often is not there according to the laws of the living being. Reagents at one time, and pressure at another, reveal, not the truths of nature, but our carelessness and presumption. I have in mind a remarkable instance of the evils of the almost monomaniacal habit of using pressure whilst investigating tissues. A celebrated physiologist, in all probability, missed the most fortunate chance of discovering the key to the whole history of the mode of origin of the embryo from the yolk-cells, simply by using a bit of thin glass to cover the object on his glass slide. Just before the segmentation of the yolk, the full-grown yolk-cells of birds, turtles, if not of all scaly reptiles, and

sharks, are very thin-walled, hyaline, globular vesicles, each one of which contains a more or less darkened mesoblast, and within the latter are a certain number of entoblasts (nucleoli). Now under the least pressure, the cell-wall bursts quickly, and the mesoblast becomes fissured or wrinkled. In this condition the mesoblast was figured and described as the yolk-cell proper, by no less careful an observer than Johannes Müller. Now in the turtle, at least, the mesoblast undergoes self-division until there are innumerable mesoblasts in the parent cells; and after the latter have congregated to form the different layers of the incipient organs of the embryo, and burst, the former unite side by side, and thus become the original cells of the young tissues.

I feel that I cannot urge too strongly the utmost necessity of studying living beings as nearly in a state of nature as is possible; to attempt this by all available means and contrivances, and, above all, patiently, not begrudging the time, because more numerous observations might be obtained by making a piecemeal and hurried show of dismembered Nature.

It would certainly be more profitable as far as living beings are concerned, if the whole world of science should, for a while at least, investigate exclusively the few transparent animals that may be obtained, than work over the numberless opaque ones which require the dissecting-knife. The first having been investigated, the knowledge of them would assist us the better to interpret the features and relations of the tissues, which we would be obliged to study in a disconnected state, just as fossils are recognized and restored by the comparative anatomist after a careful research among living models.

I have been anxious to present this communication, and to have it recorded, because certain microscopists, who are considered as high authority both in England and in this country, have attempted to depreciate the value of the flat field and wide angle of aperture in the study of living objects. This is a little remarkable, since it comes from a country where, until recently, the most finished microscopes of this kind were made, and where they are now to be found in large numbers. I will read a few passages, which may be found on page 196 of Dr. Carpenter's work on the microscope. He says:

"The author feels it the more important that he should express himself clearly and strongly on this subject, as there is a great tendency at present, both among amateur microscopists and among opticians, to look at the attainment of that 'resolving power' which is given by angular aperture, as the one thing needful; those other attributes which are of far more importance in almost every kind of scientific investigation, being comparatively little thought of; and he therefore ventures here to repeat the remarks he made upon this subject, in his recent Presidential address to the Microscopical Society, of the correctness of which he has been

since assured, by the approval of many of those who have most successfully employed the microscope in physiological investigations: 'The superiority in resolving power possessed by object-glasses of large angular aperture is obtained at the expense of other advantages. For even granting that there is no sacrifice of that most important element, *defining* power (which can only be secured, with a very wide angle, by the utmost perfection in all the corrections), yet the adequate performance of such a lens can only be secured by the greatest exactness in the adjustments. Only that portion of the object which is *precisely* in focus can be seen with an approach to distinctness, everything that is in the least degree out of it being imbedded (so to speak) in a thick fog; it is requisite, too, that the adjustment for the thickness of the glass that covers the object, should exactly neutralize the effect of its refraction; and the arrangement of the mirror and condenser must be such as to give to the object the best possible illumination. If there be any failure in these conditions, the performance of a lens of very wide angular aperture is *very much inferior* to that of a lens of moderate aperture; and, except in very experienced hands, this is likely to be generally the case. Now to the working microscopist, unless he be studying the particular classes of objects which expressly require this condition, it is a source of great inconvenience and loss of time to be obliged to be continually making these adjustments; and a lens, which, when adjusted for a thickness of glass of $\frac{1}{100}''$, will perform without much sensible deterioration with a thickness either of $\frac{1}{80}''$ or of $\frac{1}{120}''$, is practically the best for all ordinary purposes. Moreover, a lens of moderate aperture has this very great advantage, that the parts of the object which are less perfectly in focus can be much better seen; and therefore that the relation of that which is most distinctly discerned, to all the rest of the object, is rendered far more apparent. Let me remind you, further, that almost all the great achievements of microscopic research have been made by the instrumentality of such objectives as I am recommending. There can be no question about the large proportion of the results which continental microscopists may claim, in nearly all departments of minute anatomical, physiological, botanical, or zoological investigations, since the introduction of this invaluable auxiliary; and it is well known that the great majority of their instruments are of extremely simple construction, and that their objectives are generally of very moderate angular aperture. Moreover, if we look at the date of some of the principal contributions which this country has furnished to the common stock,—such as the 'Odontography' of Professor Owen, the 'Researches into the Structure of Shell' carried out by Mr. Bowerbank and myself, the 'Physiological Anatomy' of Messrs. Todd and Bowman, the first volume of the 'Histological Catologue' by Prof. Quekett, and the 'British Desmideæ' of Mr. Ralfs,—we find sure reason to conclude that these researches *must* have been made with the instrumentality of lenses, which would in the present day be regarded as of very limited capacity.—I hope that, in these remarks, I shall not be understood as in any way desirous to damp the zeal of those who are applying themselves to the perfectionizing of achromatic objectives. I regard it as a fortunate thing for the progress of science, that there are individuals whose tastes lead them to the adoption of this pursuit; who

stimulate our instrument makers to go on from one range to another, until they have conquered the difficulties which previously baffled them; and then apply themselves to find out some new tests, which shall offer a fresh difficulty to be overcome. But it is not the *only*, nor can I regard it as the *chief* work of the microscope, to resolve the markings upon the Diatomaceæ, or tests of the like difficulty; and although I *should* consider this as the highest object of ambition to our makers, if the performances of such lenses with test-objects were any fair measure of their general utility, yet as I think that I have demonstrated that the very conditions of their construction render them inferior in this respect for the purposes of ordinary microscopic research, I would much rather hold out the reward of high appreciation (*we* have no other to give) to him who should produce the *best working microscope*, adapted to all ordinary requirements, *at the lowest cost.*"

Notwithstanding the approval of those, as Dr. Carpenter says, "who have most successfully employed the microscope in physiological investigations," I do not hesitate for a moment to declare, that nothing could be more pernicious to the best interests of science than these remarks. It is unfortunate that such mistaken views should be displayed on this subject, where so great confidence has been placed,—by one, too, whose elementary works on physiology have raised the belief, among many, that he is perfectly conversant with those very tissues which require the nicest and most rigid microscopical investigation.

The illustrations which I have given of the great value of highly corrected lenses in the study of minute structures, are sufficient, I think, to refute these views; but I would like to say a few words more in conclusion, especially in reference to the general relations of microscopical investigations to other departments of natural history.

To say that objectives with a wide angle of aperture and a flat field, are needed for only a few bodies, such as test-objects, like the Diatomaceæ and other known difficult subjects, is to ignore the whole great department of histology, and by that to refuse physiology one of the most important aids; in fact, an aid which, with the help of better microscopes, in future, is likely to take the lead in the determination of the laws of animal and vegetable life. I am well aware that the study of histology has been pursued with the ordinary instruments, of the German pattern, in a great measure; but knowing what these have done both in Europe and in this country, and having discovered, by a few glimpses, how much more, and how much better, we might have done, had we possessed one of these highly finished instruments, I can confidently assert, that it is a grave error to tell opticians they had better devote themselves more particularly to the improvement of the ordinary instruments, and let their transcendental corrections of widely gaping objectives serve in the mean while as playthings for curious amateurs.

But it is a still more serious mistake to say to students, that an instrument which performs under a variety of circumstances "without much sensible deterioration" is practically the best for all ordinary purposes.

So thought Ehrenberg, and yet we all now know what curious mistakes he made. Embryology, too, comes under this proscription; for any one who has attempted to trace the development of animals, especially the lower forms of life, must know that it is impossible to separate the study of their cellular structure from the investigation of their organs.

I cannot more fittingly conclude this communication, than by quoting, by Mr. Spencer's leave, a portion of a recent letter of his to me. He says: "It seems to me that there is every reason to hope much from the earnest application of high powers with large angles. So blind and inveterate has been the prejudice in favor of low powers and small angles, in histology, that younger and less prejudiced microscopists have a comparatively untrodden path before them. Every day's thought convinces me more and more deeply of the radical mistake that has been made in this direction. I have recently been making some observations and experiments with low angles on certain well-known structures, and have in several instances been struck with a blank astonishment at the utterly false, though apparently reliable, results obtained. It happens, too, that the physical and optical characters of those tissues which, oftener than any others, are the subjects of your study, are precisely such as will lead to the most frequent errors; and if you do not find that many a blunder has been made in their study, heretofore, I shall be greatly surprised."

ART. V.—*On Brewsterite;* by J. W. MALLET.

TWO analyses of the mineral species Brewsterite are on record, those of Connell* and Thomson,† both made many years ago. The results were:

	Connell.	Thomson.
Silica,	53·666	53·045
Alumina,	17·492	16·540
Baryta,	6·749	6·050
Strontia,	8·325	9·005
Lime,	1·346	·800
Water,	12·584	14·735
Peroxyd of iron,	·292	.....
	100·454	100·175

* Edinb. N. Phil. Jour., No. XIX, p. 35.

† Outlines of Mineral. Geol. and Min. Anal., vol. i, p. 348.

It is strange that in Thomson's Outlines of Min., Geol., &c., the analysis of Connell is given with altogether different figures—thus:

Silica,	52·400
Alumina,	15·918
Baryta,	5·827
Strontia,	7·709
Lime,	1·007
Water,	·208
Peroxyd iron,	12·584
	95·653

Dr. Thomson remarking at the bottom of the page that the specimen analyzed by himself consisted of fine crystals carefully selected, while that examined by Mr. Connell was a mixture of amorphous and crystallized mineral.

The method for the separation of baryta, strontia, and lime, employed by Connell—probably by both analysts—namely, the solution of nitrate of lime and afterwards of chlorid of strontium, in alcohol—has given place to more reliable processes, and on this account a repetition of the analysis might be desirable; but it becomes still more so when the close analogy of brewsterite to heulandite is considered. The two species should in all probability have the same general formula, and this has in fact been assigned to them in Dana's Mineralogy, but with the formula for heulandite these older analyses of brewsterite do not very well agree.

I have recently analyzed some fine specimens, from the original locality—Strontian in Argyleshire, Scotland—and the results appear fully to establish the chemical as well as crystallographic relationship with heulandite.

The mineral formed crusts of minute crystals upon the surface of gneiss: sometimes these crusts could be detached from the rock by careful blows, but in general they adhered very firmly. Some of the crystals were an eighth of an inch in length—most of them were much smaller. The following measurements were obtained—using the lettering of Dana.

$O : \frac{1}{6}\text{-}i = 175° \ 49'—175° \ 53'—175° \ 55'$

$\frac{1}{6}\text{-}i : \frac{1}{6}\text{-}i = 171° \ 43'—171° \ 40'.$

$I : I = 136° \ 13'.$

$O : 1\text{-}i \ (?) = 157° \ 23'—157° \ 17'—157° \ 20'—157° \ 22'.$

$I : i\text{-}i = 112° \ 13'—112° \ 17'—112° \ 12'.$

The spec. grav. was found = 2·453.

For analysis the crystals were carefully broken off, and picked clean from any dust of the accompanying rock. In one case, the mineral was fluxed with carbonate of soda, so as to ensure perfect decomposition, and consequent purity of the silicic acid

weighed; the other specimens were treated directly with hydrochloric acid, which seems of itself to be capable of effecting complete decomposition. The baryta was precipitated by hydrofluosilicic acid,* and the relative amounts of lime and stroutia were determined indirectly, by weighing the mixed earths first as sulphates and then as carbonates.

The following are the results obtained—

	(1)	(2)	(3)	(4)	(5)	Mean.		Atoms.
Silica, - -	54·49	53·66	54·31	54·84	....	54·42	1·209	4·08
Alumina, - -	15·42	15·29	15·05	....	....	15·25	·296	1·
Peroxyd of iron,	*trace*	·08	*trace*	....	....	....	....	
Baryta, - -	6·76	6·84	....	....	....	6·80	·089	·304—1·03
Strontia, - -	8·79	9·20	....	....	....	8·99	·173	
Lime, - -	·92	1·46	....	....	....	1·19	·042	
Water, - -	13·39	....	....	....	13·06	13·22	1·469	4·96
	99·67					99·87		

Analysis (4) was spoiled by an accident; and in (3) the determination of the earths was abandoned on ascertaining the necessity for the removal of ammoniacal salts before precipitating baryta (vid. note), a precaution which had not been taken in this case.

The silicic acid, alumina, protoxyds and water are clearly present in the ratio 4 : 1 : 1 : 5, giving the formula

$$(BaO, SrO, CaO), SiO_3+Al_2O_3, 3SiO_3+5HO.$$

The atomic relation between the lime, baryta and strontia is near 1 : 2 : 4.

* In examining the precautions incident to this mode of determining baryta in the presence of strontia or lime, I have found no notice taken in any work on chemical analysis of the solvent effect of ammoniacal salts upon silico-fluorid of barium. Fresenius states that the latter dissolves in 3400 to 3800 parts of water, and in 640 to 733 parts of water acidified by hydrochloric acid, but does not mention salts of ammonia.

I digested pure silico-fluorid of barium in the cold, with frequent stirring, for forty-eight hours—(*a*) with a saturated solution of chlorid of ammonium, (*b*) with the same solution diluted with twice its volume of water. The fluid was in each case filtered off perfectly clear, 100 cubic centimetres were measured, and the baryta was determined as sulphate.

(*a*) gave ·1942 grm. of $BaO, SO_3 =$ ·2338 grm. of BaF, SiF_2. Hence 1 part of the latter salt dissolves in 428 parts of a saturated solution of sal-ammoniac.

(*b*) gave ·1409 grm. of $BaO, SO_3 =$ ·1697 grm. of BaF, SiF_2, or 1 part in 589 of the diluted solution.

The necessity of removing ammoniacal salts from a fluid in which baryta is to be determined as silico-fluorid is sufficiently obvious.

ART. VI.—*On the importance of more frequent and more accurate Deep-sea Soundings in connection with the successful establishment of a Submarine Telegraph across the Atlantic;* by Prof. W. P. TROWBRIDGE, Assistant U. S. Coast Survey.

IN the year 1849, two citizens of Philadelphia, Horatio Hubbell, Esq., and Col. John H. Sherbourne, presented a lengthy memorial to Congress promulgating a plan for establishing telegraphic communication across the Atlantic ocean; and asking the Government to aid in carrying out the project. This memorial contained the announcement of the probable existence of a table-land or plateau between Newfoundland and Ireland, in the following words.

"Your memorialists proceed to say that from many observations which have been made, there is incontestible evidence of the existence of a submarine table land extending from the banks of Newfoundland across the Atlantic ocean to the mouth of the British Channel." "This is proved by the altered color of the sea water, which has a different appearance, in unfathomable places, from what it has in shallow spots." "This combined with the volcanic construction of Iceland and the Azores, and the situation of that portion of the ocean that lies between these volcanic groups, has led to the conclusion that there has been a lifting up of the bottom of the sea, through the agency of a Plutonic power, and that the bottom thus elevated appears to be cut through, in many places, by deep-water channels." "The appearance of Medusæ, Polypi, and other marine creations, seen upon the edge of the discolored water, strengthens this opinion." "Your memorialists propose that these suggestions should be investigated," &c.

The first experiments made to test the truth of these suggestions were the soundings of Commander Berryman, made in the summer of 1853. Previous to this time no cast of the deep-sea lead had ever been made north of the Azores. The soundings of Berryman, and the subsequent soundings of Commander Dayman, have been variously interpreted concerning the proof of the existence of the submarine table-land announced by Messrs. Hubbell and Sherbourne. In a popular sense this announcement conveyed the idea of a vast unbroken level at the bottom of the sea, the existence of which has not been conclusively established by the soundings referred to.

The question, however, is one of very little importance, provided the irregularities of the bottom do not offer any serious obstacle to the safe descent of an electric cable, or cause its destruction subsequently. The question now presented is, taking the bottom of the ocean as it probably exists, with elevations and

depressions corresponding to those found upon the face of the dry land, what influence will these elevations have upon the practical operation of depositing an electric cable, and in the preservation of the electric continuity. Upon this point there has been very little discussion, on account of the popular belief in the existence of a level bottom across the only part of the ocean where a submarine telegraph has been supposed to be practicable. But even upon the line of the Atlantic telegraph, although there may not exist remarkable submarine mountains and valleys, yet it is not improbable that considerable elevations and depressions occur. The profile of Capt. Dayman differed essentially from that of Commander Berryman; so much so as to give rise to serious controversies with regard to the strict correctness of both, since to the probable uncertainties of the soundings, was added the uncertainties in relation to the intermediate depths, the soundings being made generally fifty to one hundred miles apart.

The explorations of Dayman and Berryman ought therefore to be regarded as general reconnoissances only, from which the true profile of the bottom can only be conjectured. In the explorations of the Gulf Stream by the U. S. Coast Survey, Lieutenants Craven and Maffitt discovered, off Charleston, a series of submarine ridges and depressions several hundred fathoms in height and depth in the horizontal distance of twenty to thirty miles. Such ridges and valleys would have been passed unnoticed in the explorations between Newfoundland and Ireland.

It may be taken for granted that a submarine cable should touch the bottom at every point; otherwise some parts of it must remain suspended across valleys, or chasms, of unknown depth and extent; under these circumstances its continuity is endangered by its weight, its chafing at the points of suspension, the action of currents, and other causes. Whether the Atlantic cable was destroyed by such influences or not will probably never be revealed, but it may be important to examine how far a more accurate and detailed section of the bottom may diminish the risks which must always attend an enterprise of this character.

Such ridges and elevations as were found in the Gulf Stream, though moderate in height and depth when compared with the great depths of the Atlantic, are yet of sufficient magnitude to be taken into account.

The facility with which the ocean is traversed upon its level surface, and its great horizontal extent, compared with its depth, are apt to give rise to inadequate conceptions of the real magnitude of the inequalities of the bottom,—inequalities which upon dry land would be overcome with difficulty. But when it

is intended to adapt a line to these inequalities, it is their real and not their comparative magnitudes which must be taken into account.

An accurate and detailed profile of the bottom is therefore necessary in order to estimate correctly the total amount of cable required to reach from one point to another, following the curve of the bottom, This is importont, not only in determining the total depth of cable necessary to reach from continent to continent, but also to shew at what points a greater or less surplus over the horizontal extent is needed.

It is only by the aid of accurate knowledge upon these points that the practical operation of depositing a cable can be reduced to a positive degree of safety and certainty. It was shown in a paper communicated to the American Association for the Advancement of Science at the Baltimore meeting, April, 1858, that in laying a submarine cable, *if the rate of paying out be equal to the speed of the ship, and if the speed of the ship be greater than the rate of descent of the cable in the water, the form assumed by the cable from the ship to the bottom will be a right line,* and there will be no tension upon the cable, *provided* the bottom be a uniform level plain. But if, from depositing upon a level bottom, a descending slope be reached, the cable from the ship to the bottom will form a large catenary, one end of the catenary being at the ship and the other at the crest of the descending slope.

The catenary will produce a dangerous tension upon the cable, if the descent of the slope at the bottom be very deep, unless the speed of the ship be slackened.

The failure of the first attempt to lay the Atlantic cable off the coast of Ireland was doubtless due to this cause. The bottom suddenly fell off from five hundred fathoms to seventeen hundred fathoms, a descent of seven thousand feet, and the same speed being kept up, with nearly the same rate of delivery, it was impossible for the cable to assume the form of the bottom, and a catenary of large dimensions must have been formed, causing the great tension which parted the cable. The same circumstances must occur on a smaller scale when the depression is more moderate, even in deep water: and it may happen that a submarine valley is passed before the cable has had time to descend to the crests; in which case, if the surplus paid out between the crests be insufficient, there must inevitably be a catenary formed from one crest to the other, the effect of which cannot be avoided or foreseen.

It may therefore be safely asserted, that to avoid risk of breaking a cable in the operation of depositing it upon the bottom of the sea, *the speed of the ship should be regulated by the depth and form of the bottom.* If the principle be adopted of paying out a uniform surplus to suit all the inequalities of the bottom, there

will not only be an unnecessary waste of cable in some places, but the surplus may fail to be sufficient in others, the result of which might be a rupture.

On the other hand, provided an accurate and detailed profile of the bottom be constructed, from which the exact length of cable required between any two points, however near together, can be determined, there is no reason why an irregular form of bottom should present any serious obstacle to the safe deposit of a cable, provided the speed of the ship be so regulated as to deposit the proper amount in the proper place; and it is only by following this rule that risk of breaking from the weight of the cable can be avoided.

In conclusion, the following rules may be stated.

1. Soundings of unquestionable accuracy should be made at intervals not greater than ten miles, and where there is a steep slope of the bottom, at more frequent intervals.

2. From these soundings a profile of the bottom should be made, in sections, upon a large scale, from which the length of the curve of the bottom may be calculated.

3. A chart should be constructed based upon the profile, showing the rate of speed and delivery between the different stations, in order that the cable paid out may adapt itself without tension to the curve of the bottom.

4. The profile and chart should be used as guides in the operation of laying the cable.

There is a popular belief that many parts of the Atlantic across which submarine lines of telegraph have been projected, are filled with mountains and valleys of vast magnitude. All that can be said on this subject is, that the reported measurements of great depths are neither sufficiently accurate or numerous to lead to any probable conjecture of the natural features of the bottom. And the needle-like elevations which have been represented to exist, are more the result of imagination than a representation of facts. Whatever the form of the bottom may be, an accurate profile of it is the only true basis upon which any reliable calculations with regard to the practicability of a submarine telegraph can be made.

And with the help of such accurate profiles even where great irregularities of bottom exist, the risks of failure may not be so great as has generally been supposed. And it is not improbable that the Azores might be made an intermediate station between the two continents notwithstanding the supposed rugged character of the bottom near them; while there is yet no *proof* that the bottom between the Azores and the Banks of Newfoundland is at all unfavorable to such a project.

Art. VII.—*Abstract of a paper on the Ophiurans, a tribe of Star-fishes;* by Dr. Chr. F. Lütken.*

Terminology and Morphology.

The body of an Ophiuran consists of a disc, and five or six† arms issuing therefrom. The disc contains the digestive and reproductive organs and their outward openings, namely: the mouth with its five slits (*rimae oris*) forming a star in the centre, and twenty (in *Ophioderma*, &c.) or ten (in *Ophiocoma*, &c.) genital slits, on the under surface, parallel with and close to the arms. The arms have a solid frame and are supplied with nerves, vessels and muscles, and, by reason of their length and flexibility, acquire, as organs of motions, a perfection quite wanting among the true sea-stars. On its upper surface the disc generally presents an unbroken edge, but below it is invaded by the arms, which pass along its under surface, quite to the mouth-slits. In describing Ophiuræ the mouth is placed *downwards*, the back of the disc is therefore the *upper* surface, towards the periphery is *outward*, towards the centre *inward.* The solid parts belong to three different systems, the *interior skeleton*, the *skin skeleton* and the *surface skeleton.* This is the arrangement of Gaudry,‡ though his interpretations are not always right, as will presently be seen. The interior skeleton is nothing more than the ambulacral plates turned upwards and inwards, soldered by their sides in pairs and enclosed by the interambulacral plates. It consists of a series of discoid joints (*ossicula ambulacralia—ossicules discoides*, Gaudry—*Ambulacralwirbel*, Joh. Müller,) which follow each other, like vertebræ, and are connected, partly by a sort of hinge, and partly by muscular bands extending from joint to joint. Each joint has an incision above and below, indicating the line of juncture of the two halves of which it is made up. The outer end of each joint carries a part of the hinge, consisting of three teeth, whereof the lowest runs upwards and is embraced by the two uppermost; on the inner end of the following joint is fixed the corresponding part of the hinge, namely, two edges diverging from each other below, but joined above. On the lower side is a conical cavity for the root of the tentacle.

This is the structure among the typical Ophiurans; but two points, mentioned by Gaudry in *Asterophyton*, deserve notice. The first is, that, when the arm divides in two equal branches,

* Additamenta ad historiam Ophiudarum. Af det Kgl. danske Videnskabernes Selskabs Skrifter. 5te Række 5te Bind. For this Abstract the Journal is indebted to Theodore Lyman of Boston.

† In certain species of the genus *Ophiactis* (Lütken) and in *Ophiocoma pumella* (Lüt.).

‡ Annales des Sciences Naturelles, 3me Serie Zoöl. xvi, 339.

the joint, just before the fork, has two discs, instead of one; when on the contrary a small branch is given off from the leading stem, the joints of the small branch may be traced between the joints and the skin of the stem until they become mere grains, and so disappear. And secondly, the roots of the tentacles are, in *Asterophyton*, fixed between the joints, while among the Ophiuræ they are received in a conical hole in the joint itself. The two innermost joints are the only ones which deviate much from the form already described. These are modified to form the jaw apparatus. The component halves of the last joint but one, though still remaining united, bend to the right and left, in the direction of the corresponding pieces of the neighboring arms on either side; but the halves of the innermost joint of all are completely sundered, and, inclining to the right and left, are soldered to the corresponding pieces of the neighboring arms on either side. It is these latter pieces that give the outline to the five triangular projections, which bear all the chewing apparatus (*Mundeckstücke*, Müller; *scutella oralia* or *mouth-frames*). These mouth-frames, on their sides, may be beset with mouth-papillæ. To their inner point is attached a vertical plate, the "jaw" (*maxilla, torus angularis*, Müller), and this bears the teeth (*dentes*) and the tooth-papillæ (*papillæ dentales*). Müller, in the "System der Asteriden" uses the word "*maxiller*" at random for mouth-frames and jaws. These parts are commonly visible on the outside, but, in Ophioderma and allied genera, they are covered with grains. All the rest of the interior skeleton is hidden by the skin-skeleton. Müller and Troschel, in the same work, point out the homology between the discs in the arms of the Ophiuræ and the joints in those of star-fishes; but as they started with the idea that these joints constituted a true internal skeleton, they came to the opinion that this was peculiar, and not to be found in any other Echinodermata. Gaudry, also, does not consider the interior skeleton of Ophiurans as homologous with ambulacral plates, but looks on it as a special structure in serpent-stars. It is in the side arm-plates that he finds the homologues of the ambulacra.

The *skin-skeleton* proper is to be found in the scales on the disc, the genital plates and the four rows of plates on the arms called upper, under and side plates (*scutella dorsalia, ventralia, lateralia*). To the jointed structure of the interior arm-skeleton corresponds, consequently, a similar one in the skin-skeleton. An upper, an under, and two side plates together form a joint, and this corresponds to a joint of the interior skeleton, except that the plates extend beyond their proper joint to the next outer joint. The four plates sometimes lie side by side, but again the side plates may alternate with the others, particularly when the former are little developed. As to their form, the upper plates,

as a general rule, occupy the whole upper surface of the arm, but the under plates may be square or eight-sided, and are often cut out on the sides to give room for the tentacle scales. The innermost under plate varies in shape, and is often very small. At the extremity of the arm the joints are proportionately longer and are contracted at their bases; the upper and under plates become smaller and are supplanted by the side plates, which meet on the middle lines above and below, and at last constitute almost the whole covering of the tip joints. Therefore, the shape of the plates, exposed as it is to constant changes, should always be referred to the portions of the arm close to the disc. These modifications appear sooner in species with short and quickly tapering arms, than in those with longer and more slender ones. There are, however, many serpent-stars, the inner plates of whose arms present features usually seen only at the extremities (e. g. *Ophiura*). The upper plates are sometimes divided in pieces by transverse lines; (compare species of *Ophioderma*, and *Ophiolepis imbricata*, *O. triloba*, *O. Nereis*, *O. Januarii*). *Ophiomyxa* and *Ophioscolex* are supposed to have the skin skeleton replaced by a soft dermal envelop, but there may still be seen traces of arm plates; at least in *Ophiomyxa*. The whole group of Euryalæ has the skin-skeleton either quite wanting or very rudimentary; but, to balance this, the exterior skeleton is highly developed. According to Gaudry, the four rows of little bony pieces on the under side of the arm and under the skin, among Euryalæ, correspond to the arm-plates. Along each genital opening, between it and the arm, and not visible from the outside, runs a narrow, sloping piece, the genital plate (*scutum genitale*). Its narrow end is turned inward and sometime touches a terminal piece, running from the lateral mouth-shield upwards. The outside end of the genital plate is joined with a smaller supplementary piece, which extends vertically upwards and unites again with the radial shields, at a point near the edge of the disc. These parts are never wanting: they are present, even when all other portions of the skin-skeleton have disappeared. Among the various plates and shields covering the disc are reckoned, first: the mouth-shields (*scuta oralia*), five in number, ranged in a circle about the mouth and placed in the interbrachial spaces, just outside the mouth-frames. One of these may bear the madreporic body, and is then usually somewhat different from its companions in shape. The madreporic body appears as a slight depression or elevation on the surface and communicates beneath with the "stone-canal." Along the edge of the madreporic mouth-shield there are sometimes pores.* Secondly: the lateral mouth-shields (*scutella adoralia*), which are just inside

* See J. Müller: Über die Gattungen der Seeigellarven, 1833, page 33, and Le Conte, Proc. Phil. Acad. v, p. 317, 18.

the mouth-shields and vary considerably in shape, position and size. They are arranged in pairs, a pair to each mouth-shield. Thirdly: on the back of the disc, and placed over the base of each arm, are five pairs of radial shields (*scutella radialia*), very conspicuous, when not covered by skin, spines or the like, for their peculiar form, regular position, and greater size. Fourthly: the other parts of the surface of the disc may be covered with scales, of a great variety of shapes and sizes, but usually small and rounded.* Among these scales may be pointed out two which are sometimes found (e. g. *Ophiothrix*). They start from the outer edge of the mouth-shield and run along each edge of the genital opening.

Sometimes the skin-skeleton, on the disc, is naked, (some species of *Ophiolepis* Müll. and Trosch.), but generally it is covered by a tegument of grains, or short spines (*Ophioderma*, *Ophiarachna*, *Ophiopeza*, *Ophiocoma*, *Ophiostigma*, *Ophiacantha*) granular plates and spines (*Ophiopholis*) or thorny spines (*Ophiothrix*). This tegument, together with the teeth, teeth-papillæ, mouth-papillæ, tentacle-scales and arm-spines, constitutes the *surface-skeleton*. Among the Euryalæ this covering is highly developed, and in some sort takes the place of the true skin-skeleton. On the outer parts of the arms and sometimes over the whole body, the rows of grains are armed with hooks. The lower edges of the mouth-slits may be ornamented with mouth-papillæ, which vary in size, shape and number, they may be entirely wanting (in *Ophiothrix*); in *Ophiomyxa* they take the form of lobes, beset with fine points, *Ophiactis* has but one or two on each side of the mouth-frames, *Amphiura* three, while *Ophioderma* may attain even to ten. The teeth proper are plates, arranged in a vertical row along the jaw; and the teeth-papillæ are only grains or short spines which may replace a part or the whole of the teeth; (compare *Ophiocoma* and *Ophiothrix*). It is in *Asterophyton* that the perfect homology of these variable organs is distinctly shown; in this genus all the chewing apparatus takes on the form of sharp spines. Along the underside of the arm runs a double row of pores, from which the tentacles protrude, and, on the inner side of each pore, one, two, or even four scales or papillæ (*papillae ambulacrales*) are placed, which serve to cover the tentacle when it is drawn in. They may, however, be entirely wanting (in *Ophiomyxa* and *Ophiothrix*). When there are more than one on the basal pores of the arm, they decrease in number towards the tip. At the outer end of each mouth-slit are two tentacles (*pedes orales*) which are the last pair at the base of the arm. These, according to Forbes, are used to remove the undi-

* For further remarks on the Ophiuran Skeleton, see J. Müller: Über die Ophiurenlarven des Adriatischen Meeres, 1851, p. 1, and, Über den Bau der Echinodermen, 1853, p. 51 and 76.

gested food from the mouth. The side plates of the arm carry the arm-spines (*spinae laterales vel brachiales*). These are arranged in sets, and, at the pleasure of the animal, may be raised from the arm, depressed, with their points outward, and spread and closed like a fan. They are placed either along the outside border of the plate, in which case they are small and usually pressed close to the arm; or else on a little ridge in the middle of the plate, and then their length is greater and their normal position at right angles with the length of the arm. They are never entirely wanting, but vary, in number from two to ten; in length, from one half (*Ophiura nodosa*, &c.) to six times (*Ophiothrix*) the length of a joint; and in form, from the small, smooth, tooth-like papilla of *Ophioderma* to the long glossy, thorned spine of *Ophiothrix*. As to their arrangement in the vertical rows, they are either all of the same length, or they decrease from lowest to highest and *vice versa*, or, finally, from one of the middle ones towards each end of the row. When they are rough and pointed, the lowest one, at least in the young animals and on the outer joints of the old, is commonly changed to a little hook. A striking instance is not wanting to show the strict homology between the spines and tentacle scales, for, on the innermost joint of *Ophiura texturata* these parts are so alike, that they cannot be distinguished. Towards the tips of the arm the spines diminish in number but increase in proportionate length.

Growth of Ophiurans.

The variations which the Ophiuran is subject to, from the time it leaves the egg till the serpent-star emerges from the larval condition, are explained in Joh. Müller's most admirable investigations of the metamorphoses of the Echinodermata. In regard to the variations it undergoes, after the metamorphosis has taken place, we know little or nothing, except that these variations are not unimportant. The serpent-star does not appear completely finished on emerging from its larval form; when newly born and rambling about on the surface of the water, it is not more like the full grown animal, than a young opossum is like its parents. We may see perhaps, that they belong to one or the other of the Ophiuran series, but, as to the species, we can only guess at it from the locality or abundance of the specimens. Even in the half grown animal there are still such variations from the adult form that the identity might be doubted were not the intermediate steps known. It is therefore plain, that the description of a species is not full, until several ages of that species have been properly illustrated. The following table will show approximately some changes which take place during the growth of *Ophiopholis aculeata* (*Ophiolepis scolopendrica*). The diameter of the disc, the length of the arms, the number of joints

in the arms, the number of joints with hooks on the under side and the number of joints without a circle of grains round the upper arm-plate are brought into immediate comparison.

Diameter of disc.	Length of arm.	No. of joints.	Joints with hooks.	Joints without circle of grains.
2 mm.	6 mm.	20	15	12
3		40	27	
4		45–50	33	20
6	33	63		
10	60	86		
14	72	105	40–50	18

According to this table both the disc and the arms continue to grow, but the latter the faster. During the growth of the arms new joints are formed, and this increase of joints seems greatest in the very young animal. The new joints appear at the tip of the arm and not at the base, next the mouth.

Subdivisions of genus Ophiolepis (Müll. & Trosch.).

This genus is thus described by its authors: "Naked scales, or little shields, on the disc. Mouth-slits surrounded by a single row of hard papillæ, without an increase of their number over the tooth-columns." It will presently appear, however, that the species included under this definition represent several genera. Following the suggestions of Forbes, it will be seen, that *Ophiolepis* includes two series of scaly Ophiurans, one answering in some sort to the type of *Ophioderma*, the other to that of *Ophiocoma*, as expressed in the following table.

First Series—Type of *Ophioderma.*

Mouth-shields lyre- or shield-shaped extending outwards into the interbrachial spaces, so as to separate the inner ends of the genital opening. At the base of the arms, incisions in the dorsal side of the disc. Arm-spines more or less closely pressed to the sides of the arm, and arranged along the outer edge of the side arm-plates.

Ophiura.—Disc covered with larger or smaller scales, smooth and naked radial shields tolerably large, protruding, more or less distinct. Incision in the disc limited by two arches curving outwards, and admitting three to four imperfect upper arm-plates; on its edges a close crest of from ten to thirty papillæ, which are continued underneath, along the edge of the genital opening, to the mouth-shield. Another more obscure crest of papillæ lying under the first and running only a short distance. Mouth-shields very large, generally longer than broad, shield-shaped, extending into the interbrachial spaces, thus separating the inner ends of the genital opening: the madreporic shields not differing in form. Side mouth-shields narrow, lying inside the mouth-shields prop-

er; joined at apex; their outer ends separating the mouth-shield from the innermost arm-plate. Teeth narrow, pointed, shaped like a spear-head. Mouth-tentacles coming from slits which lie just within the innermost arm-plate, and which open obliquely into the mouth-slits giving them the appearance of a Y. These slits for the tentacles are surrounded with from four to eight papillæ. Arms conical and pointed; short or of moderate length. Upper arm-plates somewhat broad. Lower arm-plates seldom touching each other, by reason of the side arm-plates which lap over and meet on the middle line of the arm. Tentacle-scales one to four. Spines short and smooth, generally arranged in three rows, on the outer edge of the side arm-plate, and pressed close to the arm. Mouth-frames furnished with mouth-papillæ. Species: *O. affinis*, *O. carnea*, *O. Stuwitzii*, *O. nodosa*, *O. squamosa*, *O. albida*, *O. Sarsii*, *O. Wetherelli* (London clay), two species from the chalk, and *O. abyssicola*, which may be an *Ophiocten*. This genus is essentially of the cold sea-belt, north of 30° North Lat.

Ophiocten.—Disc invested with scales, which are covered with flat grains and larger or smaller round spots. Incision, in disc above arms, slight, not deep enough to receive an upper arm-plate; on its edge a continuous comb of papillæ. Openings for the mouth-tentacles as in Ophiura, but not opening into the mouth-slits. Outer edges of first two or three upper arm-plates beset with papillæ. One tentacle-scale. Radial shields, mouth-shields, side mouth-shields, teeth, arms, lower arm-plates, arm-spines, and mouth-papillæ as in Ophiura. Species: *Ophiocten Kröyeri.*

Ophiolepis.—Mouth-shields small and narrow. No papillæ round the incision in the disc. Innermost tentacle-pores not placed close to mouth-slits. Dorsal scales surrounded by semicircles of small scales. Two tentacle-scales, which are placed obliquely side by side. As this group is put foremost in "System der Asteriden," the name *Ophiolepis* should be reserved for it. It is limited to the hot zone and embraces *O. annulosa*, *O. cincta*, *O. variegata* (Lüt.), *O. pacifica* (Lüt.), *O. paucispina* (Say), an undescribed West-Indian species and two new species from the west coast of America.

Second Series—Type of *Ophiocoma.**

Mouth-shields small and rounded, not extending outwards into the interbrachial spaces, so that the inner ends of the genital

* Dr. Lütken gives only a sketch of the genera belonging to the second series, as he intends to publish another part of the same work, wherein he will speak of them at greater length. The following are among the new Ophiurans described, or to be described, in the two papers: *Ophiura carnea* (Sars, Ms.) *Ophiura Sarsii* (Lütken), *Ophiura affinis* (Lüt.), *Ophiura squamosa* (Lüt.), *Ophiura nodosa* (Lüt.), *Ophiura Stuwitzii* (Lüt.), *Ophiocten Kröyeri* (Lüt.), *Ophiolepis variegata* (Lüt.), *Ophiolepis pacifica* (Lüt.), and another not yet named: *O. Januarii*, *O. triloba* and *O. Nereis.*

opening approach close to each other, on the outer side of the mouth-shield. Arm-spines mounted on a raised keel, and standing boldly out from the arm. Upper edge of the disc, at the base of the arms, entire and without incision.

Genus 1. Mouth-shields small, rounded, with a small, outward projection, separating the inner ends of the genital opening. On the back of the disc, traces of an incision at the base of each arm. Disc covered with moderate scales. Radial shields not large. Lateral mouth-shields within the mouth-shields proper. Below the teeth, two broad, flat, tooth-papillæ. Upper arm-plates divided in two. Two tentacle-scales. Three to four arm-spines. Species *O. Januarii.*

Genus 2. Arms very long and thin. Disc with very small scales, of which some, near the edge, a little larger. Radial shields very small. Lateral mouth-shields on each side of the mouth-shields proper. Upper arm-plates divided in three. One tentacle-scale. Three short arm-spines. Species: *O. reticulata, O. triloba, O. Nereis.*

Genus 3. Scales of the disc and radial shields rather small. No larger scales near edge of disc. Lateral mouth-shields within mouth-shields proper. Two tentacle-scales. Upper arm-plates covered with many small scales. Species *O. imbricata.*

Genus 4. *Amphiura.*—Disc with small, numerous scales, arranged like tiles. Radial shields very distinct. An inward curve of the disc, at the base of the arms, above. Mouth-shields small, not extending into the interbrachial spaces. Side mouth-shields within the mouth-shields. Teeth broad, quadrangular. Arms extremely long and slender. Upper arm-plates oval. Lower arm-plates quadrangular or five-sided. One, two, or no tentacle scales. Spines feeble, on a slight keel. Disc small. Six mouth-papillæ, sometimes the middle ones moved out, so as to cover the basal ones. Species *A. Chiajei, A. Holbölli, A. Orstedii, A. marginata, A. squamata,* &c.

Genus 5. *Ophiopholis.*—Disc with small and numerous scales, covered below by short spines, above by short spines and grains and by plates arranged in ten radiating rows. Radial shields covered. No incision in back of disc. Mouth-shields small, not extending into interbrachial spaces. Side mouth-shields within the mouth-shields. Teeth very broad. Arms long and thick. Upper arm-plates surrounded by small scales. Lower arm-plates square. One foot-papilla. Arm-spines close set, the lower ones, at the tip of the arm, in form of double hooks. Mouth-papillæ six to each jaw, but none under the teeth. Side arm-plates like little keels. Species *O. aculeata.*

Genus 6. *Ophiactis.*—Disc nearly as in Amphiura, but on some of the scales are a few small spines. Arms five or six, rather short and thick. Teeth broad. One or two mouth-papillæ to

each mouth-frame. Side mouth-shields wedged between first and second lower arm-plate, so as to form almost a ring round the mouth. One tentacle-scale. Three to six rough arm-spines. Seven species.

NEW OR LITTLE KNOWN SPECIES.

Ophiura carnea (Sars, Ms.).—Lütken, p. 41. Tab. I, fig. 6.

Arms rather short. Disc thick, covered above with large, rounded, angular scales. Radial shields shaped like a short, thick pear seed, inconspicuous, separated nearly by a round scale. Incision in the disc with margins almost perpendicular, with a row of twelve broad and flat papillæ on each side, which are continued by fine grains along the genital openings. Two small, perpendicular plates, side by side in each incision of the disc, with a row of papillæ on either side. Length of mouth-shields greater than breadth, and than distance from margin of disc. Under arm-plates like segments of a circle, separated from each other, without exception, by the overlapping side arm-plates. Upper arm-plates in contact at the base of the arm, but, farther out, separated by the overlapping of the side arm-plates. Three thin, weak arm-spines. One tentacle-scale. Diameter of disc 6 mm.; arms at least double that length. Color of upper surface a fine rose. Stands nearest to O. albida, from which it differs by having a thicker disc, arms shorter and broader, the innermost upper arm-plate divided in two, mouth-shields longer, and more of the upper arm-plates separated from each other. County of Bergen, 60 to 80 fathoms; Kongeströmmen, 50 fathoms; Biskopshavnen and Manger, 50 to 60 fathoms.

Ophiura Sarsii (Lütken).—Lütken, p. 42, Tab. I, figs. 3, 4.

Ophiolepis ciliata? (Stimpson, Invert. of Grand Manan, Smithson. Contrib.).
Ophiolepis ciliata, (Sars Travels in Lofoten and Finmarken).
Ophiura coriacea? (Lütken, Preliminary Rev.; from Scien. Com. Soc. Nat. Hist.).
Ophiura arctica? (Lütken, " " " " " " " ")
Ophiura glacialis? (Young ?), (Forbes).

Scale tegument varying somewhat as in allied species. Radial shields shaped like a pear seed, the small end inwards; their length to the diameter of the disc as 1 : 5 or 1 : 6 and to their breadth as 4 : 3. The rest of the scales uniform, but sometimes there is, in the middle of the back, a larger one, with rows, also of larger scales, radiating from it. Scales of under surface growing smaller towards mouth-shields. Incisions in the back of disc very deep, so as to receive four upper arm-plates; on either side a comb of ten to fifteen papillæ, of which the uppermost are on the edge of the radial shields. Outside this comb and often hidden by it, a row of small grains and a similar one along the genital opening. Mouth-shields about as in O. texturata; their length to breadth as 7 : 5. Side mouth-shields narrow and of uniform breadth at the two ends. On each side of the innermost tentacle-pores from five to six papillæ, and between these and the mouth, four to six mouth-papillæ. Upper arm-plates, at base of arms, four or five times as broad as long, but, at the tip, longer than broad. Lower arm-plate, at base of arms, twice as broad as long further out, almost disappearing. Two tentacle-scales generally, but sometimes three, or again only one. Three arm-spines, of which the lowest and shortest is not so long as the side arm-plate; the longest, at the tip of the arm, are as long as the side arm-plates; but, at the base of the arm, double that length. Color, mixed, of green, yellow and gray; sometimes light stripes on arms. The disc attains a diameter of 27 mm.; and the arms a length of 100 mm. Is distinguished from O. texturata by the different number of tentacle-scales, the different form of papillæ at incision in disc, the different shape of lower arm-plates and by wanting the pores at the base of the under surface of the arm. Young, with diameter of 4 to 6 mm., have incisions of disc less deep, fewer and proportionately larger dorsal scales, radial-shields shorter and closer together, upper arm-plates narrower, and often only one tentacle scale. These young resemble, therefore, the full grown *O. albida.* On the whole coast of Greenland, 8 to 60 fathoms, and further south at Tromsöe, also at Spitzbergen, at Floröe and Storsund in Norway, and undoubtedly at Grand Manan Is. (Stimpson loc. cit. *Ophiolepis ciliata*).

Ophiura affinis (Lütken).—Lütken, p. 45, Tab. II, fig. 10.

On the back of the disc a central large scale and fifteen others, arranged in concentric circles round it; between all these are smaller scales. Radial shields short, broad, separated by a wedge of small scales. Mouth-shields much as in *O. Sarsii.* Disc incisions with seven to nine papillæ on each side, which are strongest above. Behind these are secondary papillæ. No papillæ on the genital openings. Upper arm-plates, at the base of arm, touching each other; farther out, longer and narrower. Three thin arm-spines, the two longest equal, and as long as side arm-plates. Only one tentacle-scale. Even the innermost under arm-plates separated by side arm-plates overlapping; and they become, a little way from the disc, semicircular and almost rudimentary, being not larger than a tentacle-scale. Color bright, almost pink, with a variety of stripes on disc and of belts on arms. Diameter of disc 5 to 6 mm. and the length of arms about thrice as many. Bollaerene, Asgaardstrand, 20 to 30 fathoms. Hellebæk, 10 to 18 fathoms. This is the smallest serpent-star of North Europe and, as its name suggests, has more affinity with *Ophiocten* than the other Ophiurae.

Ophiura squamosa (Lütken).—Lütken, p. 46, Tab. I, fig. 7.

(An *O. fasciculata* [Forbes]? Sutherland's Journal of Journey, &c.)

Disc with flat, uniform scales, above rounded, below more oval. Radial shields short, thick, not conspicuous. Incisions of disc bordered by a double row of stout, equally developed papillæ. Genital openings bordered by grains. Mouth-shields small, of a regular shield-shape, as broad as, or broader than long. Side mouth-shields long, narrow, of equal breadth. On each side of the innermost tentacle-pores four or five large, round papillae. Arms thin, rather long. Upper arm-plates broad hexagonal, nearly as in *O. albida* and in young of *O. Sarsii.* Under arm-plates narrow, heart-shaped, the point inwards. One tentacle-scale. The upper arm-spine as long as a joint, and, in large specimens from Greenland, often thickened and somewhat flat; under arm-spine only about half as long. In specimens from Greenland diameter of disc as great as 10 mm.; length of arms 30 mm.; in those from the Sound, disc 7 mm., arms 21 mm.. Color; disc, above dark gray, below, ash gray; arms, green gray with darker bands. Sometimes the color is reddish, or violet, or spotted red and gray. Generally the radial shields make two bright marks, and there is a violet spot on each mouth-shield. Hellebæk, 10 to 18 fathoms; Greenland; Taarbaek; Faröe Is.; Tromsöe; Stötö; Florö; Newfoundland. Young, with a disc of $3\frac{1}{2}$ mm., have thin arms and upper arm-plates very narrow.

Ophiura nodosa (Lütken).—Lütken, p. 48, Tab. II, fig. 9.

This species and *O. Stuwitzii* stand as a separate group under the genus *Ophiura.* They are characterized by the short, stout, knotted arms, numerous tentacle-scales, very small arm-spines, and by the peculiar forms of the mouth-shields and under arm-plates. Upper surface of disc with larger and smaller, somewhat tumid scales, arranged in a rosette in the centre. Radial shields, not conspicuous, touching each other laterally, of equal breadth at each end. Incisions in disc bordered by ten short, broad papillæ in a close row. Mouth-shields twice as long as broad, nearly oval, rounded outwards, pointed inwards, extending far outwards into the interbrachial spaces. Side mouth-shields broader inwards, narrower outwards, and touching one another for some distance. Innermost tentacle-pores opening into the outer end of the mouth-slits. All the tentacle-pores oblique, while in the preceding species only the innermost pair are thus placed. From one to five tentacle-scales, according to distance from the disc. Two or three arm-spines, so short as to be like papillæ. Arms short, thick, pointed, knotted, often only twice as long as diameter of the disc. Upper arm-plates, near disc, hexagonal. Under arm-plates very narrow, the innermost in contact with each other, but the outermost separated by the overlapping side arm-plates. The diameter of the disc reaches $8\frac{1}{2}$mm., the length of the arms 17mm. Greenland, Newfoundland.

Ophiura Stuwitzii (Lütken).—Lütken, p. 49, Tab. I, fig. 8.

Disc thick, high, pentagonal. Arms short, acute, conical. Upper surface of disc with rounded, angular scales, decreasing in size from centre to periphery; under

surface with small scales. Radial shields short and broad, touching each other outwards, but within separated by a round scale. Incisions in disc shallow but wide, admitting two upper arm-plates. The scales which border the incisions run parallel with the arm-plates, so that their combs of papillæ look like the innermost rows of arm-spines; on each side, eight of these flat papillæ growing stronger above. Traces of papillæ along the genital openings. Mouth-shields twice as long as broad, narrow, rounded without, within pointed. Side mouth-shields narrow and placed within mouth-shields proper. Mouth-papillæ small on side of mouth-frames, but at the inner end, larger and pointed. Under arm-plates, at base of the arms oblong, tumid, distinctly separated from surrounding parts; but, a little further out, not raised, and having a pentagonal, or hexagonal shape. Tentacle-pores oblique. Along the outer edge of each side arm-plate, and so along the inner edge of each tentacle-pore, runs a close row of seven broad, flat papillæ, among which it is not possible to distinguish arm-spines from tentacle-scales. The innermost joints of the arm have tentacle-scales also along the outer edge of the tentacle-pores. In outer joints of arm, only one tentacle-scale and three arm-spines. Upper arm-plates, at base of arms, trapezoidal; further out, rudimentary and triangular. Diameter of disc $6^{mm.}$; length of arms $10^{mm.}$ Greenland; Newfoundland.

Ophiocten Kröyeri (Lütken).—Lütken, p. 51, Tab. I, fig. 5.

(Syn. *Ophiura sericea* [Forbes] ? Sutherland's Journal of a Journey, &c.).

Upper and under integuments of disc separated by a distinct line. Below, naked, rounded scales; above, with ten somewhat oval radial-shields, a rosette of plates in the centre and other plates scattered radiately, all of which are separated from each other by a close covering of fine grains, so that the back resembles a pavement of smaller and larger stones. Incisions in the disc only indicated by bends, which are bordered by a continuous row of papillæ. On the outer edges of the two or three first upper arm-plates, a row of papillæ. Mouth-shields a little longer than broad, of a regular shield-shape; side mouth-shields narrow; mouth-frames conspicuous. Arms rather long and thin. Upper arm-plates broad and bounded by straight cross-lines. Under arm-plates small but proportionately broad, entirely separated by the overlapping side arm-plates. Three arm-spines, about as long as the joints. One tentacle-scale, except the innermost pair of pores, where there are four. Mouth-papillæ, four or five on each side; teeth pointed as in *Ophiura*. The diameter of the disc may reach $15^{mm.}$ Spitzbergen, Arksut (South Greenland), 15 to 20 fathoms.

Amphiura Holbölli (Lütken).—Lütken, p. 55, Tab. II, fig. 13.

[Ophiolepis Sundevalli (Müll. & Trosch.) ?]

Disc flat, with very fine scales below; those above small, except some larger in the centre. Radial shields small, oblong, twice as long as broad, narrower inwards, separated by a wedge of three to five scales. Mouth-shields small, angular, rounded, a trifle longer than broad. The madreporic shield larger, and porous on its edge. Side mouth-shields broad, heart-shaped and lying within the mouth-shields. Teeth square and broad, below them a pair of stout mouth-papillæ; another pair at the outer end of the mouth-slits, and a third, lying above the second. Upper arm-plates twice as broad as long, transversely oval. Under arm-plates in contact, pentangular. One tentacle-scale. Four to five short, thin spines, as long as the joints. Color whitish. Greenland (Jacobshavn, Godhavn, Arksut). 15 to 50 fathoms. Diameter of disc $5^{mm.}$; length of arms $35^{mm.}$; but it grows larger.

Asterophyton eucnemis (Müll. & Trosch.). Young.

Young specimens with a disc of $3^{mm.}$, have the arms only once divided; at $4\frac{1}{2}^{mm.}$, twice, at $6^{mm.}$ the arms are divided thrice, and the disc is uniformly covered with tolerably large grains, but there is, as yet, no appearance of ribs.

OPHIURANS OF GREENLAND.

Ophiura Sarsii (Lütken).
Ophiura squamosa (Lütken).
Ophiura Stuwitzii (Lütken).
Ophiura nodosa (Lütken).
Ophiocten Kröyerii (Lütken).

Amphiura Holbölli (Lütken).
Ophiopholis aculeata (Lütken), (*Ophiolepis scolopendrica*, Müll. & Trosch.).
Ophiacantha spinulosa (Müll. & Trosch.).
Asterophyton eucnemis (Müll. & Trosch.).

As before mentioned, *Amphiura Holbolli* may be *Ophiolepis Sundevalli* of Johannes Müller; while Stimpson's *Asterophyton Agassizii* is probably the same as *A. eucnemis;* and his *Ophiolepis ciliata* is *Ophiura Sarsii.* To the above list is to be added a naked Ophiuran with soft skin and long thin arms, probably an *Ophioscolex;* but no good specimens have yet been obtained. If *O. arctica* turns out not to be a mere variety, there is still an eleventh species.

Finally, *Ophiothrix fragilis* has been reported from Greenland, and other very cold localities; but this is perhaps more than doubtful. On the Scandinavian coast, from Cape Kullen, in the south of Sweden, opposite the north point of Zealand, to Lofoten, on the northwest coast of Norway, there are found nineteen species of Ophiurans. On the shores of Finmarken (northwest coast of Norway) there are, thus far, six species; and on those of Great Britain, thirteen species. The geographical distribution of the Ophiurans of Greenland is as follows:

Ophiocten Kröyeri, *Amphiura Holbölli,*	Greenland and Spitzbergen, limited to the arctic zone.
Ophiura nodosa, *Ophiura Stuwitzii,* *Asterophyton eucnemis,*	Only in the *western* Atlantic; at Greenland and Newfoundland.
Ophiura Sarsii, *Ophiacantha spinulosa,*	Essentially arctic, though found in the northern temperate sea-belt, as well as at Spitzbergen and the European and American coasts of the polar sea.

Ophiopholis aculeata—On both sides of the Atlantic, through the whole arctic and cold temperate zones. *O. squamosa* has probably the same range.

Art. VIII.—*On a Visit to the Recent Eruption of Mauna Loa, Hawaii;* by Prof. Robert C. Haskell, of Oahu College, Honolulu. (From a letter to one of the Editors).

Our party consisted of Pres. Beckwith, Prof. Alexander, myself and twenty students of the college. Twelve of us went to the source of the flow. Only two persons besides have thus far reached it, though many have visited the stream on the plain between Hualulai, Mauna Kea and Mauna Loa.

The eruption broke out on the 23d of January. No earthquake was felt in any part of the Islands at the time, but dead fish were noticed on the 21st and for a few days afterwards, to the east of Molakai and between Molakai and Oahu. The fish gave no evidence of disease, but seemed to have been parboiled. At Honolulu, 200 miles from the eruption, the atmosphere was exceedingly hazy and thick. So much was this the case that it caused considerable excitement, before the news of the eruption arrived.

Rev. Mr. Lyons of Waimea states that on Sunday afternoon, Jan. 23d, smoke was seen gathering on Mauna Loa. In the evening, lava spouted up violently near the top of the mountain on the north side, and apparently flowed both towards Hilo and towards the west side of the island. This continued but a few

minutes, when at a point considerably farther below the top and farther west, another jet spouted up.

Accounts from Hilo say, that on the night of the 23d it was so light there that fine print could be read without difficulty. After the 23d the light was much less.

At Lahaina, more than 100 miles distant, the whole heavens in the direction of the eruption were lighted up.

Our party started from Honolulu Feb. 1st, and reached Kealakekua on the 3d. Here we learned that the stream from the eruption had reached the sea on the 31st of January, at Wainanalii, about forty miles from the place of eruption. This makes the average progress of the stream above five miles per day. After procuring guides, natives, pack-oxen and mules we started for the source of the flow on the 5th. About noon we had a *view* of the source distant probably 25 miles from us in an air line. The crater was about 150 feet high and 250 feet in diameter (as we afterwards estimated). From within this crater, liquid lava was spouting up to the height of 300 or 400 feet above the top. In shape and movement it resembled a mighty fountain or jet of water, though more inconstant. At one moment it was uncommonly high and quite narrow at the top, at the next not as high but very broad. At night and from a good position near, the view of the jet, according to Mr. Faudrey (the only man who reached the crater while the jet was spouting) was grand beyond all description.

Owing to an accident which befell one of our party, and the failure of water where it was supposed to be abundant, we were delayed two days and induced to divide our party into two divisions. One part returned to visit the flow at a point some twenty miles below by another and easier route. The party who went on, consisting of twelve white persons and thirty kanakas, reached the crater Wednesday evening, Feb. 9, and encamped about two miles from it. Here all fears about water were at an end, for we found snow in abundance within half a mile of our camping-ground. In the evening our view was magnificent. The jet had ceased to play; but two craters, about eighty rods apart, were sending up gas and steam, with appearances of flame. This apparent flame, however, we afterwards ascertained was only fine particles of scoria heated to redness. The noise attending this action was like that of an ascending rocket, very much increased of course, but quite irregular. About half a mile below the lower of the two craters, the stream first made its appearance. For five or six miles its course was well defined, and there were no side-streams. From this point the main stream divided more or less, and on the plain, between the three mountains Hualalai, Kea and Loa, the branches extended over a breadth of three or four miles. Some of these

streams were very broad and sluggish and partially cooled, some were narrow and running, as it seemed, at the rate of two or three miles per hour, burning the jungle and trees before them and vieing with each other in their work of desolation.

For the first few miles the stream appeared to be a series of cataracts and rapids. As it approached the plain between the two mountains, it gradually changed into a net-work of streams, or a lake of fire, embracing numerous islands and sending out streams on all sides. The color of the stream upon its first appearance was a light red approaching to white; on the plain a deep blood-red. From the plain towards Wainanalii the stream was narrow, varying from half a mile to a mile in width, and showing only a dull reddish light.

Such was the view spread out before us. To say that it combined the magnificence of a conflagration with the sublimity of a mighty mountain torrent, may give some idea of it; yet such was the extent and variety of the scene that no adequate comparison can be found. The next morning we moved our camp down to the new lava, about half a mile from the lower crater. Here we melted snow, cooked our food, and boiled our coffee over steam cracks. The day proved very foggy and rainy, but we were able to make some explorations about the craters. On the windward side we could ascend them and look in, though the heat was so great that we could look for a moment only, before turning our faces away. The sulphurous gases also were so strong that we were obliged to close our mouths and noses as we approached to look in. The craters were both very irregular in shape, not only on the outside but in the inside. No liquid lava was seen in either at the time. In each there were two or three separate holes where gases and steam were issuing. The sides of these holes and indeed the entire bottom of the craters were at a white heat. The lava stream appeared to be running underneath these craters, and the holes within seemed to be merely vents for the escape of gases. The craters were formed of fragments of light scoria and lava combined. The lower of the two (the one in which the jet was thrown up for fifteen days) was now open on the lower side. This was not the case while the jet was thrown up, according to Mr. Faudrey. It would seem that the force of the jet broke down the lower side, and that after this the jet ceased to play. The upper crater was closed on all sides.

Above these two craters we visited a third not then in action, but still hot. This was smaller and open on the lower side, and broken down somewhat on the upper side. This was formed, not so much of scoria as of old lava. Above this we could see others still of the same kind, and it is probable that they extend to the place where the lava first spouted out. From that place

to the craters then in action, the stream appears to have flowed under the surface mostly, but to have been forced up to the surface where these craters now inactive appear, by hydraulic pressure, or by the pressure of gases, or by both combined.

The next morning we visited the point where the stream first made its appearance. Here we found the lava rushing out from its subterranean passage, and dashing over cataracts and along rapids at such a rate that the eye could scarcely follow it. The lava was at a white heat and apparently as liquid as water. Only a few feet from where the stream issued, small masses of lava were thrown up from ten to fifty feet into the air, which cooled in falling. The cause of this without doubt was the escape of gas, and we then thought that the gas might come from the stream itself. But about three hours afterwards we returned to the same place, and found that the action had greatly increased. Gases were escaping at two other points a few rods below the point first seen. Pieces of lava were thrown as high as 150 feet, and, at the lowest of the three points, there was a fountain some twenty-five feet high. The bits of lava thrown up cooled as they fell, and had already formed craters ten feet high around two of the points where gases were escaping. It was now evident that the escaping gases were not derived from the stream simply, but issued from a vent, which reached to the common reservoir within or under the mountain. We could not remain to watch this incipient crater and fountain, but we were obliged to commence our return. At night, however, from our encampment, about twelve or fifteen miles below, we could see that the crater had increased considerably and also could see the fountain playing a few feet above, but the course of the stream had now changed in part, and half or more of the lava passed down by a new stream. This dashed all our hopes of seeing another large jet of 300 feet in height; and from a friend of mine who visited the spot three or four days afterwards, I learn that the fountain had ceased, and that the crater increased only a few feet after we left.

Descending by the stream, we were able to follow it on its south side, as a strong wind was blowing from that direction. Here we found good walking, and could with safety approach within a few feet of the channel. The width of the stream was from 20 to 100 feet, but its velocity almost incredible. Some of our party thought it 100 miles per hour. We could not calculate it in any way, for pieces of cold lava thrown into it would sink and melt almost instantly. The velocity certainly seemed as great as that of a railroad car. For eight or ten miles the stream presented a continued succession of cascades, rapids, curves, and eddies, with an occasional cataract. Some of these were formed by the nature of the ground over which it flowed,

some by the new lava itself. The stream had built up its own banks on each side, and had added to the depth of its channel by melting at the bottom. The stream flowed more gracefully than water. In consequence of its immense velocity and imperfect mobility, its surface took the same shape as the ground over which it flowed. It therefore presented not only hollows but ridges. In several places for a few feet the course of the stream was an ascent of five to ten degrees, in one instance of twenty-five. Where the turns in the stream were abrupt, the outside of the stream was much higher than the inside. So much was this the case, that the outside sometimes curved over the inside, forming a spiral. It is needless to add that we were filled with wonder and admiration at the sights we saw.

After arriving at the plain between the mountains we had so much fog and rain that we could explore but little. We however saw "*pahoihoi*" or solid lava forming, and also "*aa*" or clinkers. "Pahoihoi" was formed mostly by small side streams and always by shallow streams, which flowed freely but slowly. They were derived generally from the overflowing of the main stream. After flowing for some distance they became cooled at the end, and as there was little pressure from behind, gradually stopped. The little ridges which give the "*pahoihoi*" a ropy appearance, were caused by the flowing on of the stream for a little after it had cooled forward. These are circular because the sides of the stream cool first, while the centre moves on a little farther. These streams become solid in a short time, cooling through, and not simply coating over. At a subsequent time during the same flow, another layer of "*pahoihoi*" may be formed upon the first, as we saw in several instances.

The clinkers are always formed by deep streams, and generally by wide ones, which flow sluggishly, become dammed up in front by the cooling of the lava and in some instances cooled over the top, forming as it were a pond or lake. As the stream augments beneath, the barriers in front and the crust on the surface are broken up, and the pieces are rolled forward and coated over with melted lava which cools and adheres to them more or less. Then, from the force of the melted lava behind and underneath, the stream rolls over and over itself. In this way a bank of clinkers ten to forty feet high, resembling the embankment of a railroad, is formed. Often at the end of the stream no liquid lava can be seen, and the only evidence of motion is the rolling of the jagged rocks of all sizes down the front of the embankment. Sometimes the stream breaks through this embankment and flows on for a time until it gets clogged up again, and then the same processes are repeated. In this latter case the outbursting stream often carries as it were on its back immense masses of clinkers, which look like hills walking. We found no clinkers

until we reached the plain, and it would seem that none are formed except where the descent is but little, or the lava but imperfectly melted.

There is only one point more of which I will speak. I am not quite satisfied that there is a fissure in the side of the mountain, through which the lava made its exit to the surface. Those of our party who had seen the flow of 1840 and who had no doubt of a fissure in the side of the mountain then, think that there is no fissure in this case. I do not of course believe in the old theory of a perpendicular duct or pipe reaching down to the reservoir of lava, but it seems to me that the lava by the pressure of gases and steam works its way to the surface as the water of springs by hydraulic pressure. Hydraulic pressure also constitutes a part of the force which impels lava. Mauna Loa is full of caves, passages, &c., and very porous, and besides the lava, in case of this flow at least, could melt its way more or less, where it met obstructions. It may be, however, that there is a rent in the side of the mountain.

Note.—We have received from Prof. Alexander of Honolulu a map giving the course of the lava, and enabling us to make a correction in the map published in the last number of this Journal. The course there given was copied from the "Commercial Advertiser" of Honolulu. It requires only that the current should be made to flow west-north-west from near its point of starting, and then on reaching the base of Hualalai, bend northwestward into the course given in the map.—Eds.

Art. IX.—*On some points of Agricultural Science;* by Samuel W. Johnson, Professor of Analytical and Agricultural Chemistry in the Yale Scientific School, and Chemist to the Connecticut State Agricultural Society.

The Absorptive properties of Soils.—It has long been vaguely known, that the soil possesses a remarkable power of absorbing a great variety of bodies. How the soil absorbs odors (more properly the volatile matters that give the sensation of odor) has often been seen in the case of garments upon which the fetor of the American skunk has fallen. The Indians long ago taught that they might be "sweetened" by burying them in the earth; and indeed we are told that these people sweeten the carcass of the skunk by the same process to render it fit for eating. Dogs and foxes bury bones and meat in the ground, and afterward exhume them in a state of comparative freedom from offensive odor.*

* It is well known that some surfaces have a much greater power of attaching odors to them than others. Every person has observed that woolen garments retain smells longer than cotton or linen ones, and it appears that the color with which a cloth is dyed affects its retentiveness for some odors. It is a fact, as the

In the older treatises on agronomy we find allusion made to the power of soils to absorb gases, and this power, especially as exercised toward carbonic acid and ammonia, has been assumed to be of much agricultural significance, although the lack of precise experimental knowledge as to its extent, has been confessed and lamented.

The absorptive power of the soil not only for odors and gases, but also for fixed matters carried into it in a state of solution, is illustrated in certain commonly occurring instances. Thus the wells in densely populated cities, or in the vicinity of barn-yards, or filthy canals, remain sweet and pure for a greater or less period of time, though they must be constantly receiving waters that have been in contact with putrefying animal matters. The filtration of the foullest water through a thin stratum of loamy earth removes all unpleasant effluvium and taste.

In the year 1850 it became known through two interesting articles published in the Journal of the Royal Agricultural Society of England,* that the soil exerts an absorptive power toward certain substances, ammonia and potash especially, but not toward hydrochloric, nitric and sulphuric acids, so that if dilute solutions of hydrochlorate, nitrate, or sulphate of ammonia or potash are filtered through, or agitated with a certain quantity of soil, the salts are decomposed, the bases remain in insoluble combination with the soil, and the acids are found in the solution united for the most part to lime.

Previous to 1850, the absorbent power of the soil was explained as a result merely of the surface attraction of porous bodies. Thus Liebig in his "Chemistry applied to Agriculture and Physiology," referred the condensation of ammonia in soils, to the surface attraction of oxyd of iron, alumina and humus, and compared this power of soils to that exhibited by charcoal, which absorbs 90 times its volume of ammonia gas, and evolves it again on moistening with water. He also says, deciding from analogy but in the absence of experimental data, and erroneously, "*the ammonia absorbed by the clay or ferruginous oxyds is separated by every shower of rain, and conveyed in solution to the soil.*"

The separation of organic odors and coloring matters from foul water by contact with earth, has been considered analogous to the action of animal charcoal, by which, for example, beer

writer has personally observed, that when a skunk has emitted its stench in the cellar of a house, the odor clings most perceptibly to *silver ware* which has been buried among napkins in the recesses of a "china closet" long after it has disappeared from every other article on the premises. It is probable that the soil, or some of its ingredients, "sweeten" a garment as above stated, by first effecting a transfer of the odorous matter from the surface of the fabric to its own surface, and then destroying it by oxydation in the same manner as operated by charcoal and platinum black. See note on p. 73.

* On the absorbent Power of Soils." By H. S. Thomson. Vol. xi, pp. 68–74; and "On the Power of Soils to absorb Manure." By J. Thomas Way, Consulting Chemist of the Roy. Ag. Society. Vol. xi, pp. 317–380; also, vol. xiii, pp. 123–142.

and wine may be deprived of odor,* color and taste, and to that of alumina which forms insoluble *lakes* with organic pigments.

Way, in his comprehensive investigations before alluded to, after studying separately as far as possible the absorptive effect of each ingredient of the soil, was led as a last resort to investigate the relations of the silicates to saline solutions. The simple silicates he found ineffectual and had recourse therefore to the complex silicates. He digested feldspar with solution of chlorid of ammonium but detected no reaction, and thence concluded that the fragments of granitic rocks could not perceptibly decompose saline solutions. In order to trace the action of such silicates as are formed to a small degree in the wet way in soils by the weathering of the granitic minerals, Way next prepared double silicates of alumina with the bases potash, soda, lime and ammonia respectively. In the first place he procured an alumina-potash- or alumina-soda-silicate, by precipitating the soluble alkali-silicates with a salt of alumina; on digesting these double silicates with solutions of lime and ammonia, he succeeded in replacing the potash and soda by lime and ammonia, though but incompletely, for different preparations of his alumina-ammonia-silicate contained but 4·51 to 5·64 per cent of ammonia instead of the quantity equivalent to the partly displaced alkali which, according to him, in case of the alumina-soda-silicate, should be 15·47 per cent.

Way gives as characteristic of this class of double silicates, that there is a regular order in which the commonest protoxyd bases replace each other. He arranges them in the following series:

Soda—Potash—Lime—Magnesia—Ammonia:

and according to him, potash can replace soda but not the other bases; while ammonia replaces them all: or each base replaces those ranged to its left in the above series, but none of those

* Several years ago Stenhouse found that the disinfecting property of charcoal depends, not merely upon the condensation in its pores of odorous matters, but also upon their destruction by the condensed oxygen with which doubtless, it is charged. The writer (after Stenhouse) has kept the carcass of a dead rat all summer long in the working room of the Yale Analytical Laboratory without its evolving any disagreeable effluvium, simply by burying it an inch deep in powdered charcoal. The only odor that is perceived, is a strong one of pure *ammonia*, and in time, all the putrefiable parts of the carcass disappear, the hair and bones only remaining. The animal matters enveloped in charcoal (or other highly porous body capable of condensing oxygen, as platinum black or platinum sponge; probably also most soils, especially those rich in humus) are completely oxydized to water, carbonic acid and ammonia (free nitrogen?), without the appearance of the intermediate and fetid products that occur in putrefaction. The sweetening of meat by charcoal (or earth?) consists in the oxydation (eremecausis) of the putrefying surface. Stenhouse found that platinized charcoal (charcoal ignited after moistening with chlorid of platinum) makes an excellent escharotic and disinfectant for foul ulcers, and latterly the surgeon is employing permanganate of potash—an energetic *oxydizing agent*—for the same purpose.

on its right. Way remarks, that "of course the reverse of this action cannot occur." Prof. Liebig (Ann. de Chem. u. Phar., xciv, 380) has drawn attention to the fact that Way directly contradicts himself in describing the preparation of the potash-alumina-silicate, which may be obtained by digesting either the lime-alumina- or soda-alumina-silicate in nitrate or sulphate of potash, when the soda or *lime* is dissolved out and replaced by potash.

Way was doubtless led into the error of assuming a fixed order of replacements by considering these exchanges of bases as regulated after the ordinary manifestations of chemical affinity. His own experiments abundantly show that among these silicates there is no inflexible order of decomposition, nor any *complete* replacements.

Liebig, in the paper just cited, was led from this contradiction and from other considerations, to reject the conclusions of Way, especially as there was no direct proof that these double silicates exist in soils.

The recent researches of Eichhorn, "Ueber die Einwirkung verdünnter Salzlösungen auf Ackererde," (Landwirthschaftliches Centralblatt, 1858, ii, 169, and Pogg. Ann., No. 9, 1858,) have cleared up the discrepancies of Way's investigation (which is itself one of remarkable interest), and have confirmed and explained his facts.

As Way's artificial silicates contained about 12 per cent of water, the happy thought occurred to Eichhorn to test the action of saline solutions on native hydrous silicates. He accordingly instituted some trials on chabazite and natrolite, an abstract of which is here given.

On digesting finely pulverized chabazite with dilute solutions of chlorids of potassium, sodium, ammonium, lithium, barium, strontium, calcium, magnesium, and zinc, sulphate of magnesia, carbonates of soda and ammonia, and nitrate of cadmium, he found in every case that the basic element of these salts became a part of the silicate, while lime passed into the solution. The rapidity of the replacement varied exceedingly. The alkali-chlorids reacted evidently in two or three days. Chlorid of barium and nitrate of cadmium were slower in their effect. Chlorids of zinc and strontium at first, appeared not to react; but after twelve days, lime was found in the solution. Chlorid of magnesium was still tardier in replacing lime.

Four grams of powdered chabazite were digested with 4 grams chlorid of sodium and 400 cubic centimeters water for 10 days. The composition of the original mineral (I), and of the same after the action of chlorid of sodium (II), were as follows:

	I.	II.
SiO_3, - - -	47·44	48·31
Al_2O_3, - - -	20·69	21·04
CaO, - - -	10·37	6·65
KO, - - -	0·65	0·64
NaO, - - -	0·42	5·40
HO, - - -	20·18	18·33
	99·75	100·37

Nearly one-half the lime of the original mineral is replaced by soda. A loss of water also has occurred. The solution separated from the mineral, contained nothing but soda, lime and chlorine, and the latter in precisely its original quantity.

By acting on chabazite with dilute chlorid of ammonium (10 grams to 500 c. c. water) for 10 days, the mineral was altered, and contained 3·33 per cent of ammonia. Digested 21 days, the mineral, dried at 212°, yielded 6·94 per cent of ammonia, and also had lost water.

These ammonia-chabazites lost no ammonia at 212°, it escaped only when the heat was raised so high that water began to be expelled; treated with warm solution of potash it was immediately evolved. The silicate appears to be slightly soluble in distilled water, the solution giving with solution of iodid of mercury in iodid of potassium, the yellow coloration indicative of ammonia.

As in the instances above cited, there occurred but a partial replacement of lime. Eichhorn made corresponding trials with solutions of carbonates of soda and ammonia, in order to ascertain whether the formation of a soluble salt of the displaced base limited the reaction; but the results were substantially the same as before, as shown by analyzing the residue after removing carbonate of lime by digestion in dilute acetic acid.

Eichhorn found that the artificial soda-chabazite reëxchanged soda for lime when digested in a solution of chlorid of calcium; in solution of chlorid of potassium both soda and lime were separated from it and replaced by potash. So, the ammonia-chabazite in solution of chlorid of calcium, exchanged ammonia for lime, and in solutions of chlorids of potassium and sodium, both ammonia and lime passed into the liquid. The ammonia-chabazite in solution of sulphate of magnesia, lost ammonia but not lime, though doubtless the latter base would have been found in the liquid had the digestion been continued longer.

It thus appears that in the case of chabazite all the protoxyd bases* may mutually replace each other, time being the only

* Eichhorn's observations indicate that the combined (basic?) *water* of a silicate is also liable to be increased or removed. May not the small amount of water of many specimens of properly anhydrous minerals be thus acquired? May not in some cases the loss by ignition in minerals, be due to ammonia that has entered into combination in the same manner?

element of difference in the reactions. Natrolite however was not affected by digestion with chlorid of calcium. Eichhorn suggests that its soda is more firmly combined than that of chabazite.

These observations of Way and Eichhorn promise to yield the most fruitful results, not only to the theory of chemical geology, as elucidating the formation and alteration of minerals, but also to the science of agriculture. The explanation of the retentive power of soils which Way first proposed thus acquires an incalculable significance. It is plainly a true explanation, as now relieved from the constraint of a fixed order of affinities or replacements; though not the only or a complete explanation.

Voelcker in some valuable researches on the absorbent power of a soil for the liquids of the dung-heap (Journal Roy. Ag. Soc. of Eng., xviii, 149) first showed that it is not always true that the bases displace *lime* from soils. He found to the contrary, in one instance, that lime was fixed and potash displaced. This result, as well as the opposite behavior of ammonia-chabazite and natrolite towards solution of chlorid of calcium in Eichhorn's trials, indicate most clearly *that different silicates suffer different displacements, though in general, certain bases react more speedily and are more largely or firmly retained than others.* Obviously a great number of experiments are wanted on the behavior of other silicates, native and artificial, towards saline solutions in various degrees of concentration, and at different temperatures, as well as in mixed solutions, before we can decide many interesting questions suggested by these results; but we have undeniably an important new generalization with reference to the reactions that may occur among minerals and in the soil.

Economy of the Ammonia naturally accumulated in the soil.—Since it has been proved that enormous quantities of ammonia exist in soils in a state of such intimate combination that the usual means (boiling with fixed caustic alkalies) fails to expel it,* the important question has arisen—how may this ammonia be rendered more rapidly available to vegetation than it is, so as in many cases to forestall the necessity for nitrogenous manures.

The displacement of ammonia from the ammonia-chabazite by potash, soda and lime, indicates a partial solution of this question; and may not the remarkably diverse effects of various saline manures, e. g. common salt, gypsum, sulphates of soda and magnesia, and silicate of potash, as well as carbonate and phosphate of lime, depend, to some degree, on reactions analogous to those above described! We know that very small doses

* In 1855 the writer found that there was no limit to the evolution of ammonia, when attempting to estimate it in soils, and Dr. Mayer (Ergebnisse. Ag. Chem. Versuche in München 1 Heft.) could not recover by boiling with caustic potash nearly all the ammonia he purposely added to a soil.

of salt and gypsum, to take familiar examples, often remarkably enhance the productiveness of a soil, and as often fail to produce any good effect, either in small or large applications. Neither of the constituents of common salt is found to much extent in our usually cultivated plants, and soda is often entirely wanting.

The action of common salt and gypsum, especially of the latter, is most frequently similar to that caused by ammoniacal manures, whether these be applied to the soil or administered in gaseous form, as is now done in hot-houses by means of carbonate of ammonia, after the plan proposed by Ville, and is manifested in a more intensely green and luxuriant development of foliage, and increased content of water and of nitrogen. The "fixing power" of gypsum cannot longer be considered a useful quality of this fertilizer *in the soil*, not only because, in the merely moist soil, sulphate of ammonia would react on carbonate of lime, as Boussingault long ago demonstrated, but for the reason that the soil has itself a greater and more than sufficient power to fix ammonia, whether it be present as carbonate or sulphate. It is on the other hand the *unfixing* power of gypsum —its ability to liberate ammonia from the ammonia-silicates, that may in some cases constitute its merit.

General law of Displacement among saline Fertilizers.—We are every day drifting further from what but a few years ago was considered one of the most fixed and beneficial principles of agricultural science, viz. that a substance is chiefly a fertilizer because it directly feeds the plant, and are learning from the numerous recent and carefully conducted experiments with manures, that in very many cases we cannot safely venture to predict what will be the influence of a given application; but find in practice the strangest and most discordant results, it being literally possible to show from the experience of the farm that almost every fertilizer in use has in some instances proved beneficial to every cultivated crop, and in other cases has been indifferent or even detrimental.

We are therefore compelled more and more to regard the *indirect action* of manures, and the principle brought out by the researches of Way and Eichhorn, appears adapted more than any other yet discovered to generalize the phenomena of indirect action, and enable us to foresee and explain them. Proofs are not wanting of the actual operation of this principle in the soil.

Wolff (Naturgesetzlichen Grundlagen des Ackerbaues, 3d ed. p. 148,) found in fact that the ashes of the straw of buckwheat grown with a large supply of common salt, compared with the ashes of the same part of that plant grown on the same soil *minus* this addition, contained less chlorid of sodium but much more chlorid of potassium: there having occurred *an exchange of bases* in the soil.

The probabilities already adduced in favor of the view that ammonia is made available by gypsum, carbonate of lime, &c., are in point, and in the further course of this article other evidences will be brought forward to the same effect. May not the influence of lime and guano (or the carbonate of ammonia resulting from its decomposition,) in some cases be partly due to their fluxing the anhydrous or non-absorbent silicates of the soil, thus giving origin to absorbent silicates, as well as to their displacing effect on silicates already existing?

But it is of little use in the absence of decisive investigations to speculate on these topics except for the purpose of exciting research. A great field is opened here and with this new clue to guide us it should be speedily explored.

Not merely the bases, but, as *a priori* would seem entirely reasonable, the acids also appear to be capable of similar exchanges and substitutions.

Way, Liebig and others, have repeatedly observed that phosphoric acid is absorbed by soils, and from the trials of Voelcker before referred to it would appear that among the acids there occur displacements analogous to those established between the bases. Thus in one experiment in which the drainings of a manure heap were passed through a soil, there were found in an imperial gallon—

	Before filtration through the soil.	After filtration through the soil.
Silica,	·75	2·38
Phosphates of lime and iron,	7·90	1·54
Sulphate of lime,	2·18	7·92
Carbonate of lime,	17·46	79·72
Carbonate of magnesia,	12·83	6·17
" " potash,	85·27	4·29
Chlorid of sodium,	22·85	18·90
" " potassium,	35·25	26·44

In another case were found

	Before filtration through the soil.	After filtration through the soil.
Silica,	4·75	15·08
Phosphates of iron and lime,	36·32	33·14
Sulphate of lime,	7·14	*trace.*
Chlorid of sodium,	50·91	48·48
" " potassium,	30·32	39·49
Carbonate of potash,	148·69	85·93

The entire analyses have not been quoted as I do not now intend to discuss these results fully, but merely wish to direct attention to the fact that in both instances silicic acid (perhaps *only* as the result of an excess of carbonate of potash in the dung-liquor to which the soil was subjected) has been removed from the soil, and phosphoric acid has been fixed by it, while in one case sulphuric acid has been retained and chlorine lost by the soil, and in the other case the reverse has occurred.

Liebig in the paper before referred to remarks that "a clay or lime-soil poor in organic matter, withdraws all the potash and all the silicic acid from a solution of silicate of potash; whereas one rich in so-called humus (humic acid), extracts the potash, but *leaves the silicic acid* in solution."

Oxyd of iron and alumina, or some of their compounds which are present in all soils, are the most obvious means of fixing the phosphoric acid of soluble phosphates, and Thenard (Compt. Rend. Feb. 1, 1858,) has experimentally demonstrated that they do remove phosphoric acid perfectly from solutions of phosphate of lime in water saturated with carbonic acid. Déhérain (quoted in Landwirthschaftliches Centralblatt, 1859, i, 94,) has shown on the other hand that carbonate of lime and ferric phosphate brought together with highly carbonated water, give rise to phosphate of lime and ferric carbonate. According to the same experimenter phosphate of alumina and ferric phosphate are also decomposed by contact with solutions of the alkali-carbonates. Thenard in the paper just cited asserts that silicate of lime and phosphate of alumina decompose each other in carbonated water. However complicated and obscure these reactions may be, it is plain, that, henceforth, *the effect of a solution of one base in displacing other bases from native hydrated aluminous (and ferric?) silicates, and of one acid upon the compounds of other acids with oxyd of iron and alumina, must be considered in the theory of the action of saline manures.*

Water as the medium by which the ingredients of the soil enter the plant.—From his experiments on the absorbent power of soils Way was led to question the influence of water in effecting the distribution of plant-food in the soil, and Liebig in a recent paper on this subject (Uéber einige Eigenschaften der Ackerkrume" Ann. der Chem. u. Phar. cv, 109 et seq.*) has drawn the conclusion that this force in the soil is so powerful that ammonia, potash and phosphoric acid when applied as manures are instantly made quite insoluble, so that we must relinquish the idea hitherto entertained that plants appropriate their food directly from an aqueous solution, and must adopt as an only alternative the doctrine that the roots of the plant themselves attack and solve their nutriment. Liebig is of the opinion that the bodies mentioned cannot be distributed in the soil by the ascending and descending streams of moisture which are perpetually circulating in it, in obedience to gravitation and evapotion, and he adduces analyses of river, spring and drain waters, which are almost free from potash and ammonia to sustain this view.

On the other hand Eichhorn in the paper already referred to, found that *pure distilled water dissolved from a soil much more of*

* See also his "Letters on Modern Agriculture," London, 1859.

all the mineral matters required by vegetation than would be needful to supply any average crop. Henneberg and Stohmann (über das Verhalten der Ackerkrume gegen Ammoniak u. Ammoniaksalzen, Ann. der Chem. u. Pharm. cvii, 170) found that when a soil had been saturated with ammonia, pure water removed it again to a certain extent. Thus 100 grams of soil were treated with 200 c. c. of a solution of chlorid of ammonium (containing 0·693 grams ammonia) and absorbed 0·112 grams of ammonia; on removing one-half of the solution and substituting as much pure water the soil lost 0·009 grams of ammonia as the result of the dilution: by again replacing with water 100 c. c. of the thus diluted solution, 0·014 grams of ammonia were redissolved from the soil, and by five repetitions of this process 0·053 grams or nearly one-half the quantity of ammonia originally absorbed passed again into solution.

Liebig himself in one of his papers (Ann. der Chem. u Pharm. cvi, 201,) has furnished the best illustration of the manner in which one base is made soluble by being displaced from its combination with the soil on the addition of another base. He says—"If sulphate of ammonia in very dilute solution, is brought in contact with soil saturated with silicate of potash, and which does not give up a trace (?) of its potash to water alone, it instantly dissolves a certain quantity of this alkali, which may be easily detected by the common reagents."

Liebig has not overlooked the case of aquatic plants whose roots do not enter any soil, for which, he remarks—"there must of course exist other laws for the absorption of their mineral food; they must absorb it from the surrounding medium."

But there appears to be no reason for supposing that aquatic plants differ from our cultivated crops in the manner of imbibing or appropriating the nourishment which enters the roots, especially since Sachs and Stoeckhardt (Chemischer Ackersmann 1859, p. 28, *et. seq.*) have shown that the cereals and leguminous grains, as well as clover and beets, not only germinate but attain a vigorous development and even blossom; although their roots never come in contact with a solid soil, but merely float in water holding in solution the salts needful to supply them with mineral food.

It must be borne in mind that the amount of mineral (fixed) ingredients in a plant or crop is but a minute fraction (according to Boussingault $\frac{1}{1500}$ on the average, according to Lawes and Gilbert $\frac{1}{3000}$) of the quantity of water which a plant or crop under usual circumstances transpires during its season of growth. We are not surprised then, that agricultural plants are sufficiently fed when their roots are merely surrounded by ordinary well water which is daily changed, or by distilled water mingled with a little vegetable ash into which carbonic acid is daily con-

ducted. We know that drain tubes and aqueducts are often choked by a mass of rootlets which have grown from one little fiber that made its way into them through a narrow crevice, but why should the roots of trees and land plants thus develop in such water unless they find their food in it? In Stoeckhardt's experiments *loc. cit.*, it was observed that rye and oats only developed in a normal manner in saline solutions, when these were diluted from six to ten thousand times! and young clover plants grew luxuriantly, putting forth new roots, leaves and blossoms in profusion, when transferred from the soil to pure water supplied with carbonic acid, to which was added $\frac{1}{500}$th of clover ashes that had been neutralized with nitric acid.

It is true that most river and spring waters yield by analysis but the minutest traces of potash, ammonia and phosphoric acid, but we cannot perhaps infer with safety that they are actually so deficient in these ingredients, for it may easily happen, as all chemists know, that in the evaporation of a large mass of water traces of salts are likewise carried off,* and in the ignition of saline residues, as is customary in the analysis of a water, much more loss of potash may occur from the ready volatility of chlorid of potassium.

But admitting that our analyses are sufficiently accurate to base calculations upon, and that the soil-water never contains more potash for example than river and well waters; viz., from 2 to 10 parts in 1,000,000,† it must be remembered that the plant is by no means compelled to limit itself for its supplies of mineral matter to that portion of water which it transpires.

The root-cells of a plant placed in a saline solution at once establish osmotic currents, in virtue of the mutual but unbalanced attractions that exist between the cell-walls, the liquid of the cell, the surrounding liquid and the saline and organic matters in solution in these liquids. The assimilating processes going on in the cells are constantly transporting matters forward into the newer growths; or else removing them from solution in the sap, and causing their deposition in the solid form. These are the prime disturbances that operate the currents, and to restore the matters thus removed from the liquids of the root-cells, external matters held in solution diffuse inwardly. If a plant has a large leaf surface exposed to the free air, from which water rapidly evaporates, water diffuses into the root-cells if it be

* In Liebig's Chemistry applied to Agriculture and Physiology (5th German ed., p. 102, et seq.) may be found an account of some of the more striking instances of this volatilization. My friend, Dr. Robert A. Fisher permits me to mention the result of some of his researches that bear on this point. He found in fact that a quantity (very small indeed but still sufficient to be estimated by volumetry) of *caustic potash* is carried off in the vapor when its aqueous solution is distilled.

† Eichhorn found in 1,000,000 parts of distilled water that had been in contact with a soil for ten days, 57 parts of potash.

present in the soil, and thus the normal humidity of the structure is preserved. But if the plant be situated in a close hothouse, or in a Ward's case, the atmosphere of which is constantly saturated with aqueous vapor, there can be no evaporation of water from the leaves, there can be no transpiration of water through the plant and no absorption of it by the roots, except to supply what becomes a solid constituent of the tissues or is decomposed in the nutritive process. The same is true of potash or any other substance held in solution in the soil-water. As a result of this principle the land plant collects the potash, phosphoric acid, silica, &c., needed for its organization, from the vastly dilute solutions of these bodies which form the water of wells or of the soil, just as the fucus gathers its iodine from the ocean, although the marvellously delicate reagents which we possess for iodine scarcely enable us to detect this substance even in highly concentrated sea-water.

Says Gmelin, (Handbook of Chemistry, Cavendish Soc's. ed., vol. ii, p. 248,) "the quantity of iodine contained in sea-water is so small that Tennant, Davy, Gaultier, Fyfe and Sarphati were not able to find it. Balard, however, found it in the water of the Mediterranean and Pfaff in that of the Baltic, which is nevertheless very poor in iodine." Otto (Lehrbuch 3d ed., 1st Part, p. 452,) observes "while bromine is easily found if not in the sea-water itself, yet in the mother-liquors obtained by its evaporation, and is prepared from them in large quantities, it is still doubtful if iodine can be detected in them." Again in a note—"It is worthy of remark that in preparing bromine from the mother-liquors of sea-water, iodine, so far as I know, has never made its appearance."

Iodine can be detected in a solution of which it forms but $\frac{1}{300000}$th part—Otto.

The *selecting power* which is possessed by plants is fully explained and defined by osmotic diffusion. Within certain easy limits the plant imbibes only those kinds of matter and those quantities, which it requires to develop its organism, and which diffuse into it in consequence of assimilation in the cells. These limits are not so narrow or inflexible as to make the finding of the conditions of growth impossible, and within them, the plant lives and expands, but is itself influenced in its life and in the direction of its enlargement, by the quantities, absolute and relative, of the nutritive or soluble matters, that happen to surround it. Could we grow two plants in precisely identical conditions, we should find their composition alike in all their parts. The variations in the composition and amount of the ash of plants is probably connected with the different relative development of the separate organs, and this again (in part) with the relative quantities of food present in the soil water. Thus the ash of

the plant is to a certain extent independent of the soil, but again to a certain extent is affected by it. The absorption of *poisons* by plants is entirely abnormal and does not affect our statement.

Not only does the grand law of osmose (endosmose and exosmose) feed the plant out of such attenuated solutions, but, in all probability it aids the formation of these solutions. Graham has shown in the case of alum and bisulphate of potash that the unequal diffusive tendency of the members of a double salt is powerful enough to decompose it, and he observed that solutions even of the neutral sulphates of potash and soda diffused their basic ingredients into lime-water, more rapidly than the acid; these stable salts thus undergoing partial decomposition.

The investigations of Henneberg and Stohmann already cited, have proved that the absorbent power of a soil is not a purely chemical process, in the ordinary restricted sense; but is in part a physical phenomenon, i. e., it does not depend exclusively upon the presence in the soil, of a certain amount of some peculiar *kind* of matter, but is also related to the *condition* and to the relative amount of acting surface of the various materials which react.

Henneberg and Stohmann found that the *time of contact* between a solution of an ammonia-salt and a soil did not affect the amount of absorption,—as much ammonia being taken up in four hours as in a week. This fact indicates that the absorbing substance is in an extreme state of division, to which the pulverized chabazite of Eichhorn's experiments can bear no comparison.

They found too, that a given soil absorbed out of an equal volume of liquid very nearly the same amount of ammonia from equivalent quantities of all its salts, the *phosphate* excepted.

They observed however that the *relative quantities* of soil, water and the saline substance, affected the results; thus from a stronger solution a greater absolute amount of ammonia was absorbed, while from a weaker solution a relatively greater quantity was taken up: and further, relatively more was absorbed by a given amount of soil, from a solution of given strength when the *volume* of the latter was increased.

Finally they found, as has been already remarked, that by diluting with pure water the solution from which a soil had saturated itself with ammonia, a portion of this body is redissolved.

Thus it appears that the very surface-attractions which determine the solution of solid bodies, and occasion osmotic diffusion, also operate in the soil to influence the chemical affinities which are the prime cause of its absorptive properties. The chemical affinity of silicate of alumina for the bases, (probably too that of oxyd of iron and alumina for some of the acids) is modified by the mass of the reacting substances and by that of their solvent; or in other words the cohesive force of the atoms of the com-

pound silicates, or the adhesive force of water, (solvent action) for the saline bodies, may neutralize or limit the chemical affinity which determines one compound and give origin to another. Hence the chemical substitutions in the soil, and in the case of chabazite: hence too the perpetual presence of all the mineral food of plants in the water of the soil.

We would not by any means deny the direct action of the rootlets of plants upon the soil, an action which though exceedingly obscure and as Prof. Liebig remarks in enunciating his new views "very difficult to form a conception of," we may admit in some cases.

Liebig in his letters on modern agriculture, p. 43, gives this instance: "We frequently find in meadows smooth lime-stones with their surfaces covered with a network of small furrows. When these stones are newly taken out of the ground, we find that each furrow corresponds to a rootlet, which appears as if it had eaten its way into the stone." We may admit in this case that the rootlets have acted upon the stone, but are not therefore necessarily compelled to assume that the dissolved matters have entered the plant or were dissolved as food, for in such lime-soils the excess rather than the deficiency of carbonate of lime is oftener a hindrance to vegetation. In the case of the *Lycopodiaceæ*, which contain *alumina* in large quantity combined with tartaric acid, (Berzelius) or malic acid (Ritthausen) we are, if any where, obliged to look to the plant itself, to account for the entrance into it of a substance absent from all cultivated plants if our numerous analyses are to be credited, and one which is rarely found in river waters, and then in quantity so small as to excite the suspicion that it has been introduced in the reagents, or came from suspended matters.

But it is evident from the facts that have been adduced that it is unnecessary to have recourse to any new theory to explain the access of the soil-ingredients into the plant. In fact it would appear that the view we have felt forced to sustain is the only one admissible in the present state of knowledge—the only one conformable to what we deem well established physical laws.

Conclusion.—The function of the soil.—While the researches of Eichhorn are of the utmost value in aid of the theory of the absorption of fertilizing matters by the soil, they do not suffice to give a full explanation of this process. Doubtless all the reactions that occur between hydrous silicates, sesquioxyds and saline solutions may take place in the soil; but in addition to these a number of other changes must go on there, as the soil is so complex and variable a mixture. The organic matters (the bodies of the humic acid group), which are often though not always present in no inconsiderable quantity in the water extract of fertile soils, can hardly fail to exert an influence to modify the action of the silicates. I have found that a peat (swamp-

muck) from the neighborhood of New Haven, (containing when fully dry 68 per cent of organic matter) which is highly prized as a means of improving the porous hungry soils in this vicinity, and which when drained grows excellent crops, is capable of absorbing 1·3 per cent of ammonia, while ordinary soil absorbs but 0·5 to ·1 per cent.

The great beneficent law regulating these absorptions appears to admit of the following expression: *those bodies which are most rare and precious to the growing plant are by the soil converted into, and retained in, a condition not of absolute, but of relative insolubility, and are kept available to the plant by the continual circulation in the soil of the more abundant saline matters.*

The soil (speaking in the widest sense) is then not only the ultimate exhaustless source of mineral (fixed) food, to vegetation, but it is the storehouse and conservatory of this food, protecting its own resources from waste and from too rapid use, and converting the highly soluble matters of animal exuviæ as well as of artificial refuse (manures) into permanent supplies.

Yale Analytical Laboratory, May 15th, 1859.

ART. X.—*On Fossil Plants collected by Dr. John Evans at Vancouver Island and at Bellingham Bay, Washington Territory.*—In a letter from L. LESQUEREUX to J. D. DANA, dated Columbus, Ohio, May 12, 1859.

Dear Sir,—Supposing that Prof. Heer who is now engaged in publishing a magnificent *Fossil Flora of the Tertiary* of Europe, would be much interested in the examination of the plants of Dr. John Evans' survey, of which a short description is published in the last number of your Journal, I sent him a sketch of the drawings prepared for Dr. Evans' report. I have just received an answer to the communication, and as it fixes the value of my species and gives some opinions which are of great interest to American geology, I take the liberty of translating a part of his letter and sending it to you for publication.

Prof. Heer says: "I have hailed with the greatest delight the news which you give me in your letter of 21st March. They are the first rays of light penetrating the dark night which until now has covered the tertiary flora of America, and the day is close at hand, when the fog which still darkens the wonderful flora of those times will be uplifted, and the New World open to us its treasures. They will prove of the greatest interest for the natural philosophy of the earth, and give us most important information as to the relation of climate at the tertiary epoch, and to the secular progression or distribution of temperature over the whole earth. But it is also of the greatest importance for the

history of the American flora, to discover through the plants of the tertiary the various elements of which it is composed; the time will surely come when we shall be acquainted with the true characters of the different floras and with the history of their formation."

"You very correctly remark that the examination of the tertiary flora of Oregon and Vancouver shows that the flora is nearly related to the European flora of the same epoch. Among your species, we find some which are considered as particularly characteristic of our tertiary; viz. the species of *Cinnamomum. Cinnamomum crassipes*, Lsqx., is hardly distinguishable from *C. Rossmaesleri*, Heer. It is a pity that the point of the leaf is wanting; it would at once decide the matter, showing whether the nerves ascend to the point or disappear below it, as is the case in *C. lanceolatum*, which is also very similar.—*Cinnamomum Heerii*, Lsqx., is not so certain in its identity. At any rate, it would better agree with *C. polymorphum* than with *C. Buchii*, which is broader just above its middle. What makes me doubtful here, is that the fine nervules emerge at an acute angle, while in *Cinnamomum* they have a somewhat different direction. Perhaps your drawing in this is not quite correct, for in every other respect, the leaf as far as it is preserved would well agree with our *C. polymorphum*. As to *Planera*, I perfectly agree with you, that it is not possible to separate it from *P. Ungeri*. *Salix Islandica*, Lsqx., in its form and general outline resembles our *Salix macrophylla*. But if the nervation is rightly marked, your leaf cannot belong to that species. In *Salix macrophylla*, as in the willows generally, we have, besides the percurrent secondary nerves united near the margins, some other shorter intermediate secondary nerves, which emerging at an obtuse angle from the medial nerve, extend to the nearest secondary nerve either above or below and join with it. In *Salix macrophylla* these shorter secondary nerves are very close together. But in your drawing I see only secondary nerves running nearly to the margins, and if it is correct your leaf does not belong to a *Salix*. The name you give to this leaf (*Salix Islandica*) is peculiar. Your leaf could not have been brought from Iceland? I received from Copenhagen a very interesting collection of the tertiary flora of Iceland, and among the leaves there are some willows which can not be distinguished from our *Salix macrophylla*. Your maple-leaf appears to be somewhat toothed on the margins. If it is so, it would not belong to *Acer trilobatum*. However, it is not well enough preserved for ascertaining its true species. The place of your *Salisburia* is perfectly right, since a *Salisburia*, *S. adiantifolia*, has been found at Sinigaglia, which place, with Stradella and Guarenne, belongs without doubt to the upper strata of Œningen and consequently to the upper Miocene. Your leaf, Pl. 1, fig. 1, *Quercus Benzoin*, Lsqx., is the most interesting of your species,

as it seems so perfectly to agree with *Oreodaphne Heerii*, Gaud., that there is scarcely a doubt of the identity of the two species. But your leaf does not show the small holes or depressions marked in the axils of both the inferior secondary nerves. You probably did not remark them. I beg you will again examine the specimen, and I feel confident that you will find there a small depression; if so, the identity of species is proved. The form and nervation of the leaves are truly peculiar and already suffcient for identification. *Oreodaphne Heerii*, Gaud., has been abundantly found in the upper Miocene and lower Pliocene of Italy, but never till now on this side of the Alps. It much resembles *Oreodaphne fœtens* of the Canary islands. You will find it figured in the paper of our friend Gaudin, which I send you. A second Italian leaf is probably your *Quercus Gaudini*, Lsqx.: I have at least seen one very like it in Gaudin's new treatise, which is not yet published, and I have not the plates on hand just now. I would take your leaf, Pl. 1, fig. 2, for *Ficus multinervis* if the secondary nerves were united in their arched points. This is not marked in your drawing. These secondary nerves are somewhat too straight to belong to *Quercus neriifolia*."

"From these few species, we can already see a near relation between the American tertiary flora and ours; and in several species, this relation passes to a true identity. We may add to your species *Glyptostrobus Œningensis*, Br., and *Taxodium dubium*, Sternb. In the U. S. Exploring Exped., during the years 1838–39–42, under the command of Ch. Wilkes, Geol., Atlas, Pl. 21, by Dana, there is a plate with figures of leaves from Frazer river, and among them, the two above named species are easily identified. Fig. 11 and 15 may belong to *Caprinus Gaudini;* but probably the margin of the leaf is not rightly drawn. Fig. 12 is like *Rhamnus Rossmaesleri* or perhaps a *Smilax*. These plants therefore confirm our conclusion."

"Another important deduction may be drawn from your plants, viz. that in the American tertiary flora, there are some Asiatic types which no longer belong to the American continent, namely *Cinnamomum* and *Salisburia;* and further an Atlantic type, the *Oreodaphne*. There is still an *Oreodaphne* in America; but the fossil species is related to *O. fœtens* of the Canary Islands. A third conclusion taken also from the same plant is that fan-like Palm trees were growing at the same time in the same latitude with *Sequoia* and *Taxodium*, and that therefore we must admit of a warmer climate in North America at that epoch. And now from this fact that a flora of the same character occurred at the tertiary epoch in Northern Europe and North America, it follows that both parts of the earth had a like warmer climate. It is a new and very important confirmation of the Atlantis! the second that I have received this month.

The first was given me by the collection of tertiary fossil plants from Iceland in which I found a *Liriodendron* (leaves and fruit) very like *L. tulipifera*, L., with six species of Pines, of which one much resembles *Abies alba.* With this, there are leaves of *Alnus, Betula, Salix, Araucaria, Acer, Sparganium, Equisetum,* &c., and in truth, species which agree perfectly with those of the tertiary flora. You will find in the general part of my Flora of the Tertiary, where I give a general survey of the tertiary flora of Europe, a detailed account of these leaves of Iceland, and also of some other parts of Europe from which I have received large collections."

"Your views of the gradation of the flora of North America agree perfectly with what we find in Europe. This led me to believe that the plants of Nebraska belong to the tertiary and not to the cretaceous formation. It is true that I have seen only some drawings which were sent to me by Messrs. Hayden and Meek; but they are all tertiary types. The supposed *Credneria* is very like *Populus Leuce*, Ung., of the lower Miocene, and the *Ettinghausiana* seems hardly rightly determined. Besides it is a genus badly founded, and which has as yet no value. All the other plants mentioned by Dr. Newberry belong to genera that are represented in the Tertiary and not in the Cretaceous. And it is very improbable that in America the cretaceous flora has had the characteristic plants of the tertiary; and this would be the case if these plants did belong to the Cretaceous."*

To this most interesting letter of Prof. Heer, I can only add a few words of explanation about his remarks on my species. I owe to the kindness of Dr. John Evans the privilege of still having his specimens in my possession; I was therefore enabled to again examine the only specimen of the leaf which according to Prof. Heer is referable to *Oreodaphne Heerii*, Gaud. Though the specimen is one of the best preserved of the collection, there is no trace of the mentioned pimples or depressions at the axils of the basilar secondary nerves as marked in the figure of M. Gaudin's memoir. One leaf agrees in its general outline and by its primary and secondary nervation with an *Oreodaphne.* But the secondary intermediate nerves are large, deeply marked, and perpendicular to the primary one; and the tertiary nervules are also mostly perpendicular to the secondary ones, well marked and mostly percurrent. This last character especially would separate our leaf from the genus *Oreodaphne* and put it rather with the oaks.—About *Salix Islandica* which I referred with

* Prof. Heer had not seen, when he wrote this, the paper by Messrs. Meek and Hayden in our last volume (p. 219), in which it is shown that the beds containing these leaves occur beneath thick strata characterized by Baculites, Ammonites and other fossils of the Cretaceous. Dr. Newberry has also identified similar leaves from beneath the Cretaceous of New Jersey (collected by Prof. G. H. Cook), and others from New Mexico; so that, if the leaves are tertiary our Cretaceous is abolished.—Eds.

doubt to *Salix macrophylla*, it is not possible to say any thing definite. The leaf is printed on coarse shaly sandstone and the secondary nerves are scarcely marked. It is from the general outline of the leaf and its denticulation, that I had to take the characters. The name *Islandica* was accidentally given as indicating a high latitude for a species of willow with such large leaves. It is truly a curious coincidence that Prof. Heer received from the tertiary of Iceland specimens of a species related to or perhaps identical with ours. *Cinnamomum Heeri*, Lsqx., is a true *Cinnamomum* in every character; but *Quercus multinervis*, figured Pl. 1, fig. 2, has apparently the points of the nerves arched and united, and is truly comparable with *Ficus multinervis* and perhaps identical with it. The specimen figured in Prof. Heer's flora is very poor, and our own is badly broken, and the points of the nerves are scarcely discernible.

Art. XI.—*Geographical Notices.* No. VIII.

Results of the recent Explorations in Australia.—We translate from Petermann's Mittheilungen, April, the following important survey of the results obtained in the recent explorations of Australia. It is principally based on official and authentic reports relating to the following expeditions:

1. Stephen Hack's Researches in the Gawler Mts., and at Lake Gairdner, 1857.
2. Major Warburton's Journey to Lake Gairdner, June and July, 1858.
3. B. Herschel Babbage's expedition to the region between Lake Gairdner and Lake Torrens, 1858.
4. Stuart's, Babbage's and Warburton's explorations north from Lake Campbell.

The article in Petermann is accompanied by a map of Australia between 133° and 138° long. east from Greenwich, and between 30°·30′ and 33° S. lat.

In order to obtain a clear insight into the advantages which have been gained by the numerous expeditions, we shall separately consider their scientific and practical results. In regard to the first view, the question arises about the unknown interior of the Continent. Although the newly explored area comprises only four degrees of longitude and as many of latitude, not extending yet one third of the distance between Spencer's Gulf and the Gulf of Carpentaria, there is new reason to assume, that the interior formation and condition of Australia have a far more varied character, than has been generally supposed. It is shown, that there is no uniform desert of stone and sand, but a

succession of tracts of lands useless and useful, part already inhabited and part capable of being so. The lake district west of the Torrens Basin is in itself a very interesting region which has given rise even in Australia to many hypotheses on the origin of the continent. The salty ingredients of the soil, the salt water lakes, and the sea-shore-like plains west of the Torrens Basin described by Stuart, were used as arguments for the supposition that this part of Australia had been lifted out of the sea in a comparatively recent period only; that in its place an arm of the sea formerly existed, which perhaps connected Spencer's Gulf with the Gulf of Carpentaria, whereby Australia was divided into two parts. These hypotheses, though pleasantly drawn out, must however be considered useless and hasty, as by a close scientific physical examination they are as likely soon to be refuted as confirmed. Even Babbage's calculations of his barometrical observations are still wanting and with them the basis most necessary to a physical examination of the country. However, in relation to height, we may assume as tolerably certain, that from Spencer's Gulf in the direction from N. to N.W., plains extend into the interior elevated but little above the level of the sea and separated from each other by plateaux. The Torrens Basin with its lagoons and coast plains forms one of these low tracts, a second one is represented by that series of lakes, which commences with Lake Dutton and ends on the other side of Lake Younghusband in several swamps and sloughs; a third is formed by the great sinkings of Lake Gairdner and its environs. Major Warburton believes that Lake Gairdner is situated below the level of the sea. If this be true, it must also be the case with the Great Salt Lake and the other adjacent lakes,—as we find in Babbage's Reports no intimation of any difference in their height. Without expressing any definite opinion we will only mention, that Gregory, in his previous expedition from Moreton Bay to Adelaide, crossed the Torrens Basin and found by barometrical means that this basin was situated decidedly above the level of the sea. But the Torrens Basin has there, as the most recent travellers in Australia affirm, its greatest depth. Warburton's opinion therefore remains for the present at least improbable.

The area of the discovered lakes is not inconsiderable, as a comparison with the Lake of Constance shows (*Area* 207 Eng. or 9·75 Germ. sq. m.). By a calculation based on sketches of charts we find

Lake Gairdner in the extent given on the chart	2807 E.	or	132 G. M.		
Great Salt Lake, - - - - -	351 "	"	16·5 "		
Lake Hart, - - - - - -	140 "	"	6·6 "		
Pernatty Lagoon, - - - - -	85 "	"	4 "		
Lake Younghusband, - - - - -	57 "	"	2·7 "		
Lake Windabout, - - - - -	49 "	"	2·3 "		
Lake Reynolds, - - - - - -	6·4 "	"	0·3 "		

Besides the plateaus, which extend in a northerly direction between the Torrens Basin and that row of lakes situated west, and also between these and Lake Gairdner, elevated perhaps only a few hundred feet above the lakes and their low shores, we find frequently series of heights and isolated elevations. With the exception of the Gawler Mountains, 3000 Engl. feet high, they do not seem to be of any consequence, for Stuart asserts in his description of Mount Finke, that this mountain, though only equal to Mount Arden, was the highest he had seen in his travels.

Concerning the other physical conditions of the country, its vegetation, fauna, etc., we shall speak when giving a more detailed report of Stuart's voyage and the further explorations of Babbage and Warburton. We shall only add in this connection a few words on the practical results of the surveys. The best impressions are undoubtedly made by Hack's descriptions of the Gawler Mountains and the region bordering them on the north and east. There, without doubt, extensive tracts of land are found with a sufficient quantity of fresh water and fertile soil well adapted to stations for cattle and perhaps even agricultural purposes, having the advantage of being easily accessible from the coast, to which they lie near. South and west we find those fearful deserts which Eyre passed through, and where Stuart and Foster suffered from hunger. Farther east in the direction of Lake Torrens, the absence of permanent sweet water springs is the greatest impediment to colonization, for good pastures are neither wanting in the low lands along the lakes, nor even on the plateaus, though we find them here in more isolated tracts. The number of springs, however, and fresh water basins seems to increase considerably the nearer you approach the interior, as Stuart's and Babbage's accounts plainly show. Even Major Warburton, one of the Australian *pessimists,* could not but express his surprise at the great number of springs on the pastures discovered by him north of Stuart's Creek, although he sees almost everything in a more unfavorable light than the rest, and thinks a permanent settlement between Spencer's Gulf and Lake Campbell an impossibility. Several thousand square miles of pasture in such a seclusion and separated by girdles of shrubs and stony plains might really seem to be unworthy of notice, if the peculiar character of Australia were not to be taken into consideration. With an increase of 100,000 souls in its population, with its rapid development in raising cattle, the want of new grass-land is felt more severely than almost anywhere else upon the earth.

We shall but add in reference to this subject, that a week after Stephen Hack's return from the Gawler Mountains a price was offered for some 2000 miles of the 4500 English sq. miles of the new discovered pastures. Several cattle owners followed

Babbage's expedition almost upon his steps, and a Mr. Macdonald was about to make Wirrawirralu his permanent station. Swinden and Stuart reserved for their own use considerable tracts of land in those regions which they discovered. A possession of fertile and useful lands is considered advantageous even if hard of access, as on the west side of the Torrens Basin, where a communication with the coast requires considerable exertion and expense. An attempt is made to overcome the want of springs by artesian wells, for which, according to Babbage, the conditions are favorable. Enterprising colonists had commenced boring already last year at different places, as for instance on the northern foot of the Baxter Mountains.

A particular account of Stuart's bold journey of discovery, illustrating and confirming the results which have been stated above, is contained in the Berlin *Zeitschrift für allgemeine Erdkunde* for January, 1859.

REPORT OF THE SUPERINTENDENT OF THE (UNITED STATES) COAST SURVEY, SHOWING THE PROGRESS OF THE SURVEY DURING THE YEAR 1857. Wash., 1858, pp. 18 and 448, 4to, with 72 plates and charts.—This valuable volume, although bearing date of last year, has been distributed only within a few months. In the brief space at our command it is impossible to state in any detail the great amount and variety of important matter which Prof. Bache has in this report so clearly and ably exhibited. The report shows most fully that the Survey is conducted with eminent efficiency, and that the highest theoretical science and the best artistic skill are brought to bear on this great national work. The astronomical, magnetic, and tidal observations so extensively carried on by the officers of the survey, are, in addition to their direct importance, of great value to the general interests of science.

The appendix, which comprises pages 121—445 of the volume, is rich in valuable notices and papers. Among these may be specified those by the accomplished Superintendent, on the *Atlantic Coast Tides,* and on the *Winds of the Western Coast of North America*, the memoir by Lieut. E. B. Hunt on an *Index of Scientific References*, and the Report by Mr. J. G. Kohl on the *Western Coast Annals of Maritime Discovery and Exploration.*

Numerous charts, diagrams, and other illustrations accompany the volume, and it is well furnished with a table of contents and an alphabetical index, which are so essential to the usefulness of such a work.

We are happy to know that these Reports are distributed with a liberal hand, so that probably every person in the country who can make any use of it, can easily obtain a copy. It gives us pleasure to see also that our government supports the Survey with such enlightened liberality, for we are confident that the outlay yields a full return to the true interests of the nation.

KOHL'S REPORT TO THE U. S. COAST SURVEY ON THE HISTORY OF MARITIME DISCOVERY ON THE PACIFIC COAST OF THE U. STATES.—The Report of the Superintendent of the U. S. Coast Survey for 1857, just published, not only contains as usual important contributions to the hydrography and topography of this country, but many discussions of general interest. Having previously referred to Dr. Kohl's investigations on the coast of the Atlantic and Gulf of Mexico, we here call attention to an outline of his report on the Pacific coast, which is given in the appendix to the volume above referred to. His report begins with a general survey of the physical features of the western coast of the U. States, written from the point of view of the navigator, not the naturalist, To this succeeds a history of discoveries on the Pacific, in groups corresponding with the periods of Cortez, Drake, and Vancouver, whose maritime enterprise was particularly distinguished. By means of notes, full references are made both to the original reports of voyages and to the subsequent discussions of them. A special hydrography of the coast has also been prepared, and two appendixes are added, the first giving reduced copies of maps and charts, ancient and modern, the second a historical map showing the additions to our knowledge made by successive explorers.

We are confident that this work when given to the public will be received with great interest. Its plan is comprehensive and its importance obvious.

DR. M. WAGNER'S VISIT TO THE CORDILLERAS, ON THE GULF OF SAN BLAS.—We find in the *Zeitschrift für allgemeine Erdkunde* (Berlin, Jan. 1859) a Report of Dr. Moritz Wagner's in respect to an important and hitherto unknown part of the Cordilleras. This well-known traveller proposed to determine the following points. 1. Do the Cordilleras, between the Gulf of San Blas and the valley of the R. Chepo consist of one or more chains? 2. Is there, between 9° 1′ and 9° 20′ N. lat. and between 80° 50′ and 81° 30′, a depression in the mountain chain favorable for an interoceanic canal? 3. Is there between the sources of the Chepo and the rivers falling into the Atlantic, really as supposed a plateau, and how high is the same? 4. What is the geological formation of the Isthmus? He condenses the results of his observations in the following words:

1. The Cordilleras, between the Gulf of San Blas and the mouth of Rio Bayano (Chepo), form one central chain passing from east to west through the Isthmus.

2. The average height of this chain is 920 to 1000 Paris feet above the Pacific Ocean at the time of high tide. The highest point reached by Wagner is elevated 1141 feet. Farther north the summits ascend higher, 1800 to 2000 feet. El Generale is estimated not to exceed 2800 feet in height.

3. Another lower chain of mountains extends along the Atlantic coast; behind it the Gulf of San Blas is situated. A valley from three to four leagues in width is extended between both chains, which are now and then connected by transversal ridges. El Generale is such a transversal ridge; it stretches from south to north and divides at the north. The northern slope of the Cordilleras is everywhere steeper than the southern. In the valley many fine prairies are found, being separated from one another by low hills.

4. The valley of Mamoni forms a considerable depression in the Cordilleras, and cuts them, as it were, through. Our camp in the centre of this pass was only 293 feet above Chepo and 374 feet above the level of the Pacific Ocean. Up to this point of the passage the river has from its source a fall of about 120 feet. As to the Madroño nothing reliable could be elicited from the natives; it is however very probable that under this name that river is meant, which on Codazzi's chart is called Rio Mandingo, and which empties into the Gulf of San Blas.

5. Almost all the mountain crests and the northern slope of the Cordilleras consist of granite, which is also found in the beds of the rivers. A great portion of the top is covered with a kind of conglomerate, either of a yellow or red color, in proportion as the oxyd of iron preponderates. Something similar is seen at the summit of Cerro del Ancon near Panama.

It is very interesting to see how at the springs of Rio Chagres the Cordilleras suddenly cease to form a continuous chain, splitting, so to speak, in little round mountains, especially between Panama and Gatim. Here also the granite disappears, being replaced by porphyry, dolerite or trap.

No part of the Cordilleras between the Gulf of San Blas and the Rio Chepo gives any indication of the possibility of establishing an interoceanic canal. The most favorable situation for this purpose is still, in Wagner's opinion, the valley of the rivers Obispo and Rio Grande, viz. the present railroad route.

African Explorations.—Petermann's Mittheilungen, for February 1859, contains brief intelligence in respect to several of the African expeditions. We make the following extracts.

Burton and Speke, who have reached the inner African sea, report that there is not one sea only, but four. The one which they have visited they call the Ugidschi; the others, Tschiwa, Nyassa, and Ukerewa.

A letter from the missionary Rebmann has the following interesting remarks, under the date of Sept. 19, 1858. "A new traveller, Dr. A. Roscher, has arrived here. I said to him that I hoped he would first visit Kilimandjaro, that it might be settled whether I had taken white stone for snow, or not. This matter is to me of the highest interest. It seems to me that if it should prove stone the mountain would be so much the more

remarkable. The peak is so white that I could think it nothing but snow, and I was not a little surprised to hear from some learned men in Europe that it was thought to be anything else."

Dr. Baikie's Niger expedition has now been two years in progress without attaining any noteworthy results. The expedition lost its first steamboat on the rocks not far from Rabba. Meanwhile all the world had learned through Dr. Barth's fifth volume, that the great western branch of the Niger, leading to Timbuktoo, offered great difficulties to navigation. It is to be regretted that the other branch, the Benue, had not before been chosen for exploration. It is now proposed to direct attention to it. Baron Krafft, under the name of Hadj Skander, has set out to visit Timbuktoo. Extracts from his diary are promised in Petermann.

The nautical director of Dr. Livingstone's expedition, Captain Bedingfield, has unexpectedly returned to England on account of a disagreement with Dr. Livingstone.

A journey from Natal to the river Limpopo is projected by two of the missionaries. The lower and middle parts of this stream, which is probably after the Zambesi, the most important of East Africa, are as yet quite unknown.

ONDARZA'S NEW MAP OF BOLIVIA.—Under the authority of the government of Bolivia, a new map of that country has recently been engraved and printed at the office of Messrs. J. H. Colton & Co., New York.

It is based upon the explorations and surveys of Col. Ondarza, Commandant Mujia, and Major Camacho, the former of whom has been engaged in the work for seventeen years, and has lately been supervising in our country this publication of his results.

The chart (which is issued in four sheets), is almost exclusively limited to the territory of Bolivia itself, but the surveys have extended toward the south into the Argentine confederation. Marginal maps are given of the La Plata and Amazon, from the respective surveys of Page and Herndon, and plans of the cities La Paz and Sucre. The depth and rapidity of the principal rivers are stated at numerous points, and the localities in which are found gold, silver, copper, or other metals are also carefully indicated.

We are informed that in the course of the surveys the elevations of more than three thousand points have been barometrically determined, many of them by repeated observations. One of the determinations affords the means of a comparison between an instrumental leveling extending between 13,000 and about 17,000 feet, and the result of an extended series of barometric observations. The elevations of several of the principal mountains are restored by these observations to the figures originally ascribed to them but very much reduced by Pentland in

his map. This is the case with Sorata and Illimani. The elevations which have been ascertained, and further scientific observations will be given in a volume soon to be published on the geography, statistics, &c. of the country.

A statistical table appended to the map gives the population of Bolivia as follows for 1858:

Provinces.	Inhab.
La Paz,	475,322
Cochabamba,	319,892
Potosi,	281,229
Chuquisaca,	223,668
Oruro,	110,931
Santa Cauz,	153,164
Tarija,	88,900
Veni,	53,973
Atacama,	5,273
Savage tribes,	245,000
Total,	1,987,352

The map appears to have been executed with great care in its details, and is a very important contribution to the orography of South America. D. C. G.

ART. XII.—*Alexander von Humboldt.*

ALEXANDER VON HUMBOLDT died at Berlin on Friday the sixth of May, having been ill with a severe catarrh accompanied by fever since the 17th of April.

Eulogy by Prof. AGASSIZ, *before the American Academy of Arts and Sciences, delivered on the 24th of May.*

Gentlemen:—I have been requested to present on this occasion some remarks upon the scientific career of HUMBOLDT. So few days have elapsed since the sad news reached our shore, that I have had no time to prepare an elaborate account of that wonderful career, and I am not myself in a condition in which I could have done it, being deprived of the use of my eyes, so that I had to rely upon the hand of a friend to make a few memoranda on a slip of paper, which might enable me to present my thoughts in a somewhat regular order. But I have, since the day we heard of his death, recalled all my recollections of him; and, if you will permit me, I will present them to you as they are now vividly in my mind.

HUMBOLDT—ALEXANDER VON HUMBOLDT, as he always called himself, though he was christened with the names of FREDERICK HEINRICH ALEXANDER,—was born in 1769, on the 14th of Sep-

tember,—in that memorable year which gave to the world those philosophers, warriors and statesmen who have changed the face of science and the condition of affairs in our century. It was in that year that Cuvier also and Schiller were born; and among the warriors and statesmen, Napoleon, the Duke of Wellington and Canning are children of 1769, and it is certainly a year of which we can say that its children revolutionized the world.

Of the early life of Humboldt I know nothing, and I find no records except that in his tenth year he lost his father, who had been a Major in the army during the seven years' war, and afterwards a chamberlain to the King of Prussia. But his mother took excellent care of him, and watched over his early education. The influence she had upon his life is evident from the fact that notwithstanding his yearning for the sight of foreign lands he did not begin to make active preparations for his travels during her life time. In the winter of 1787–'88 he was sent to the University of Frankfort on the Oder, to study finance. He was to be a statesman; he was to enter high offices, for which there was a fair chance, owing to his noble birth and the patronage he could expect at the Court. He remained, however, but a short time there.

Not finding those studies to his taste, after a semestre's residence in the University we find him again at Berlin, and there in intimate friendship with Willdenow, then Professor of Botany, and who at that time possessed the greatest herbarium in existence. Botany was the first branch of natural science to which Humboldt paid especial attention. The next year he went to Göttingen,—being then a youth of twenty years; and here he studied natural history with Blumenbach; and thus had an opportunity of seeing the progress zoology was making in anticipation of the great movement by which Cuvier placed zoology on a new foundation. For it is an unquestionable fact that in first presenting a classification of the animal kingdom based upon a knowledge of its structure, Blumenbach in a measure anticipated Cuvier; though it is only by an exaggeration of what Blumenbach did that an unfair writer of later times has attempted to deprive Cuvier of the glory of having accomplished this object upon the broadest possible basis. From Göttingen he visited the Rhine, for the purpose of studying geology, and in particular the basaltic formations of the Seven Mountains. At Mayence he became acquainted with George Forster, who proposed to accompany him on a journey to England. You may imagine what an impression the conversation of that active, impetuous powerful man made upon the youthful Humboldt. They went to Belgium and to Holland, and thence to England, where Forster introduced him to Sir Joseph Banks. Thus the companions of Capt. Cook in his first and second voyages round the world,

who already venerable in years and eminent as promoters of physical science not yet established in the popular favor, were the early guides of Humboldt in his aspirations for scientific distinction. Yet Humboldt had a worldly career to accomplish. He was to be a statesman, and this required that he should go to the Academy of Commerce at Hamburg. He remained there five months, but he could endure it no longer, and he begged so hard that his mother allowed him to go to Freyberg and study Geology with Werner, with a view of obtaining a situation in the Administration of Mines. See what combinations of circumstances prepare him for his great career, as no other young man ever was prepared. At Freyberg he received the private instruction of Werner, the founder of Modern Geology, and he had as his fellow student no less a man than Leopold von Buch, then a youth, to whom, at a later period, Humboldt himself dedicated one of his works, inscribing it "to the greatest geologist," as he was till the day of his recent death. From Freyberg he made frequent excursions to the Hartz and Fitchtelgeberg and surrounding regions, and these excursions ended in the publication of a small work upon the Subterranean Flora of Freiberg, (Flora Subterranea Fribergensis), in which he described especially those Cryptogamous plants, or singular low and imperfect formations which occur in the deep mines. But here ends his period of pupilage.

In 1792 he was appointed an officer of the mines (Oberbergmeister.) He went to Beyreuth as Director of the operations in those mines belonging to the Frankish Provinces of Prussia. Yet he was always wandering in every direction, seeking for information and new subjects of study. He visited Vienna, and there heard of the discoveries of Galvani, with which he made himself familiar; went to Italy and Switzerland, where he became acquainted with the then celebrated Professors Jurine and Pictet, and with the illustrious Scarpa. He also went to Jena, formed an intimate acquaintance with Schiller and Goethe, and and also with Loder, with whom he studied anatomy. From that time he began to make investigations of his own, and these investigations were in a line which he has seldom approached since, being experiments in physiology. He turned his attention to the newly discovered power by which he tested the activity of organic substances; and it is plain, from his manner of treating the subject, that he leaned to the idea that the chemical process going on in the living body of animals furnished a clue to the phenomena of life, if it was not life itself. This may be inferred from the title of the book published in 1797—"*Über die gereizte Muskel und Nerven-faser, mit Vermuthungen über den chemischen Process des Lebens, in Thieren und Pflanzen.*" In these explanations of the phenomena we have the sources of the first

impulses in a direction which has been so beneficial in advancing the true explanation of the secondary phenomena of life; but which, at the same time, in its exaggeration as it prevails now has degenerated into the materialism of modern investigators. In that period of all-embracing activity, he began to study Astronomy. His attention was called to it by Baron von Zach, who was a prominent astronomer, and at that time was actively engaged upon astronomical investigations in Germany. He showed Humboldt to what extent astronomy would be useful for him, in his travels, in determining the positions of places, the altitude of mountains, &c.

So prepared Humboldt now broods over his plans of foreign travel. He has published his work on the muscular and nervous fibre at the age of 28. He has lost his mother; and his mind is now inflamed with an ungovernable passion for the sight of foreign and especially tropical lands. He goes to Paris to make preparation by securing the best astronomical, meteorological and surveying instruments. Evidently he does not care where he shall go, for on a proposition of Lord Bristol to visit Egypt he agrees to it. The war prevents the execution of this plan, and he enters into negotiations to accompany the projected expedition of Capt. Baudin to Australia; but when Bonaparte, bent on the conquest of Egypt, started with a scientific expedition, Humboldt wishes to join it. He expects to be one of the scientific party, and to reach Egypt by way of Barbary. But all these plans failing, he goes to Spain with the view of exploring that country, and finding perhaps some means of joining the French expedition in Egypt from Spain. While in Madrid he is so well received at the Court—a young nobleman so well instructed has access everywhere—and he receives such encouragement from persons in high positions, that he turns his thoughts to an exploration of the Spanish provinces of America. He receives permission not only to visit them, but instructions are given to the officers of the colonies to receive him everywhere and give him all facilities, to permit him to transport his instruments, to make astronomical and other observations, and to collect whatever he chooses; and all that only in consequence of the good impression he has made when he appeared there, with no other recommendation than that of a friend who happened to be at that time Danish Minister to the Court of Madrid. With these facilities offered to him, he sails in June, 1799, from Corunna, whence he reaches Teneriffe, makes short explorations of that island, ascending the peak, and sailing straightway to America, where he lands in Cumana, in the month of July, and employs the first year and a half in the exploration of the basin of the Orinoco and its connection with the Amazon. This was a journey of itself, and completed a work of scientific import-

ance, establishing the fact that the two rivers were connected by an uninterrupted course of water. He established for the first time the fact that there was an extensive low plain, connected by water, which circled the high table land of Guiana. It was an important discovery in physical geography, because it changed the ideas about water courses and about the distribution of mountains and plains in a manner which has had the most extensive influence upon the progress of physical geography. It may well be said that after this exploration of the Orinoco, physical geography begins to appear as a part of science. From Cumana he makes a short excursion to Havana, and hearing there of the probable arrival of Baudin on the West coast of America, starts with the intention of crossing at Panama. He arrives at Carthagena, but was prevented by the advance of the season from crossing the Isthmus, and changed his determination from want of precise information respecting Baudin's expedition. He determines to ascend the Magdalena river and visit Santa Fé de Bogôta, where, for several months, he explores the construction of the mountains, and collects plants and animals; and, in connection with his friend, Bonpland, who accompanied him from Paris, he makes those immense botanical collections, which were afterwards published by Bonpland himself, and by Kunth after Bonpland had determined on an expedition to South America. In the beginning of 1802 he reaches Quito, where, during four months, he turns his attention to every thing worth investigating, ascends the Chimborazo, to a height to which no human foot had reached, anywhere; and, having completed this survey and repeatedly crossed the Andes, he descends the southern slope of the continent to the shore of the Pacific at Truxillo, and following the arid coast of Peru, he visits finally Lima. I will pass lightly over all the details of his journey, for they are only incidents in that laborious exploration of the country which is best appreciated by a consideration of the works which were published in consequence of the immense accumulation of materials gathered during those explorations. From Lima, or rather from Callao, he sails in 1802 for Guayaquil and Acapulco, and reaches Mexico in 1803, where he makes as extensive explorations as he had made in Venezuela and the Andes, and after a stay of about a year, having put all his collections and manuscripts in order, revisits Cuba for a short time, comes to the United States, makes a hurried excursion to Philadelphia and Washington, where he is welcomed by Jefferson, and finally returns with his faithful companion Bonpland to France, accompanied by a young Spanish nobleman, Don Carlo de Montufar, who had shared his travels since his visit to Quito.

At thirty-six years of age Humboldt is again in Europe with collections made in foreign lands, such as had never been brought

together before. But here we meet with a singular circumstance. The German nobleman, the friend of the Prussian and Spanish Courts, chooses Paris for his residence, and remains there twenty-two years to work out the result of his scientific labor; for since his return, with the exception of short journeys to Italy, England and Germany, sometimes accompanying the King of Prussia, sometimes alone, or accompanied by scientific friends, he is entirely occupied in scientific labors and studies. So passes the time to the year 1827, and no doubt he was induced to make this choice of a residence by the extraordinary concourse of distinguished men in all branches of science with whom he thought he could best discuss the results of his own observations. I shall presently have something to say about the works he completed during that most laborious period of his life. I will only add now, that in 1827 he returned to Berlin permanently, having been urged of late by the King of Prussia again and again to return to his native land. And there he delivered a series of lectures preparatory to the publication of Cosmos; for in substance, even in form and arrangement, these lectures, of which the papers of the day gave short accounts, are a sort of prologue to the Cosmos, and a preparation for its publication.

In 1829, when he was 60 years of age, he undertakes another great journey. He accepts the invitation of the Emperor Nicholas to visit the Ural Mountains, with a view of examining the gold mines and localities where platina and diamonds had been found, to determine their geological relations. He accomplished the journey with Ehrenberg and Gustavus Rose, who published the result of their mineralogical and geological survey in a work of which Rose is the sole author; while Humboldt published under the title of Asiatic Fragments of Geology and Climatology, his observations of the physical and geographical features made during that journey. But he had hardly returned to Berlin, when in consequence of the revolution of 1830, he was sent by the King of Prussia as extraordinary ambassador to France, to honor the elevation of Louis Philippe to the throne. Humboldt had long been a personal friend of the Orleans family, and he was selected as ambassador on that occasion on account of these personal relations. From 1830 to 1848 he lived alternately in Berlin and in Paris, spending nearly half the time in Paris and half the time in Berlin, with occasional visits to England and Denmark; publishing the results of his investigations in Asia, making original investigations upon various things, and especially pressing the establishment of magnetic observatories, and connected observations all over the globe, for which he obtained the co-operation of the Russian government and that of the government of England; and at that time those observatories in Australia and in the Russian Empire to the borders of

China, were established which have led to such important results in our knowledge of terrestrial magnetism. Since 1848 he has lived uninterruptedly in Berlin, where he published on the anniversary of his 80th year a new edition of those charming first flowers of his pen, his Views of Nature, the first edition of which was published in Germany in 1808. This third edition appeared with a series of new and remodeled annotations and explanations; and that book in which he first presented his views of nature, in which he drew those vivid pictures of the physiognomy of plants and of their geographical distribution, is now revived and brought to the present state of science. The "Views of Nature" is a work which Humboldt has always cherished, and to which in his Cosmos he refers more frequently than to any other work. It is no doubt because there he had expressed his deepest thoughts, his most impressive views, and even foreshadowed those intimate convictions which he never expressed, but which he desired to record in such a manner that those that can read between the line might find them there; and certainly there we find them. His aspiration has been to present to the world a picture of the physical world from which he would exclude everything that relates to the turmoil of human society, and to the ambitions of individual men.

A life so full, so rich, is worth considering in every respect, and it is really instructive to see with what devotion he pursues his work. As long as he is a student he is really a student and learns faithfully, and learns everything he can reach. And he continues so for twenty-three years. He is not one of those who is impatient to show that he has something in him, and with premature impatience utters his ideas, so that they become insuperable barriers to his independent progress in later life. Slowly and confident of his sure progress, he advances, and while he learns he studies also independently of those who teach him. He makes his experiments and to make them with more independence he seeks for an official position. During five years he is a business man, in a station which gives him leisure. He is Superintendent of the Mines, but a Superintendent of the Mines who can do much as he pleases; and while he is thus officially engaged journeying and superintending, he prepares himself for his independent researches. And yet it will be seen he is thirty years of age before he enters upon his American travels, those travels which will be said to have been the greatest undertaking ever carried to a successful issue, if judged by the results; they have as completely changed the basis of physical science as the revolution which took place in France about the same time has changed the social condition of that land. Having returned from these travels to Paris, there begins in his life a period of concentrated critical studies. He works up his materials then

with an ardor and devotion which is untiring; and he is not anxious to appear to have done it all himself. Oltmanns is called to his aid to revise his astronomical observations, and his barometrical measurements by which he has determined the geographical position of 700 different points and the altitude of more than 450 of them.

The large collection of plants which Bonpland had begun to illustrate, but of which his desire of seeing the tropics again has prevented the completion he entrusts to Kunth. He has also brought home animals of different classes, and distributes them among the most eminent zoologists of the day. To Cuvier he entrusts the investigation of that remarkable Batrachian, the Acœolotel,—the mode of development of which is still unknown, but which remains in its adult state in a condition similar to that of the tadpole of the frog during the earlier period of its life. Latreille describes the insects, and Valenciennes the shells and the fishes; but yet to show that he might have done the work himself, he publishes a memoir on the anatomical structure of the organs of breathing in the animals he has preserved, and another upon the tropical monkeys of America, and another upon the electric properties of the electric eel. But he was chiefly occupied with investigations in physical geography and climatology. The first work upon that subject is a dissertation on the geographical distribution of plants, published in 1817. Many botanists and travellers had observed that in different parts of the world there are plants not found in others, and that there is a certain arrangement in that distribution; but Humboldt was the first to see that this distribution is connected with the temperature of the air as well as with the altitudes of the surface on which they grow, and he systematized his researches into a general exposition of the laws by which the distribution of plants is regulated. Connected with this subject he made those extensive investigations into the mean temperature of a large number of places on the surface of the globe, which led to the drawing of those isothermal lines so important in their influence in shaping physical geography and giving accuracy to the mode of representing natural phenomena. Before Humboldt we had no graphic representation of complex natural phenomena which made them easily comprehensible, even to minds of moderate cultivation. He has done that in a way which has circulated information more extensively, and brought it to the apprehension more clearly than it could have been done by any other means.

It is not too much to say, that this mode of representing natural phenomena has made it possible to introduce in our most elementary works, the broad generalizations derived from the investigations of Humboldt in South America; and that every

child in our schools has his mind fed from the labors of Humboldt's brain, wherever geography is no longer taught in the old routine. Having completed his American labors, Humboldt published three works partly connected with his investigations in America, and partly with his further studies in Europe since his return, and among others, a book, which first appeared as a paper in the "Dictionnaire des Sciences Naturelles," but of which separate copies were printed under the title of "Essai sur la Constitution des Roches dans les deux Hemisphères." This work has been noticed to the extent which it deserved by only one geologist, Elie de Beaumont. No other seems to have seen what there is in that paper, for there Humboldt shows, for the first time, that while inorganic nature is the same all the world over,—granite is granite, and basalt is basalt, and limestone and sandstone, limestone and sandstone wherever found,—there is everywhere a difference in the organized world, so that the distribution of animals and plants represents the most diversified aspects in different countries. This at once explains to us why physical sciences may make such rapid progress in new countries, while botany and zoology have to go through a long process of preparation before they can become popular in regions but recently brought under the beneficial influence of civilization. For while we need no books of our own upon astronomy, chemistry, physics and mineralogy, we have to grope in the dark while studying our plants and animals until the most common ones become as familiar to us as the common animals of the fields in the old countries. The distinction which exists in the material basis of scientific culture in different parts of the world is first made evident by this work. By two happily chosen words Humboldt has presented at once the results of our knowledge in geology at the time, in a most remarkable manner. He speaks there of "independent formations." Who, before Humboldt, thought there were successive periods in the history of our globe which were independent one from the other? There was in the mind of geologists only a former and a present world. Those words expressing the thought and expressing it in reference to the thing itself, for the first time occur in that memoir; thus putting an end to those views prevailing in geology, according to which the age of all the rocks upon the earth can be determined by the mineralogical character of the rocks appearing at the surface. The different geological levels at which rocks belonging to the same period have been deposited, but which have been disturbed by subsequent revolutions, he happily designated as "geological horizons."

It was about the time he was tracing these investigations that he made his attempt to determine the mean altitude of the continents above the sea. Thus far geographers and geologists had

considered only the heights of mountain chains, and the elevation of the lower lands, while it was Humboldt who first made the distinction between mountain chains and table lands. But the idea of estimating the average elevation of continents above the sea had not yet been entertained; and it was again Humboldt, who, from the data that he could command, determined it to be at the utmost 900 feet, assuming all irregularities to be brought to a uniform level. His Asiatic travels gave him additional data to consider these depressions and swellings of continents, when discussing the phenomena of the depressions of the Caspian Sea, which he does in a most complete manner.

There is a fullness and richness of expression and substantial power in his writing, which is most remarkable, but which renders his style somewhat involved. He has aimed to present to others what nature presented to him,—combinations interlocked in such a complicated way as hardly to be distinguishable, and his writings present something of the kind. You see his works, page after page, running into volumes without division into chapters or heads of any sort; and so conspicuous is that peculiarity of style in his composition, that I well remember hearing Arago turning to him, while speaking of composition, and saying, "Humboldt, you don't know how to write a book—you write without end, but that is not a book; it is a picture without frame." Such an expression of one scientific man to another, without giving offense, could only come from a man so intimately associated as Arago was with Humboldt. And this leads me to a few additional remarks upon his character and social relations. Humboldt was born near the Court. He was brought up in connection with courtiers and men in high positions of life. He was no doubt imbued with the prejudices of his caste. He was a nobleman of high descent. And yet the friend of kings was a bosom friend of Arago, and he was the man who could, after his return from America, refuse the highest position at the court of Berlin, that of the secretaryship of public instruction, preferring to live in a modest way in Paris, in the society of all those illustrious men who then made Paris the centre of intellectual culture. It was there where he became one of that Societé d'Arcueil, composed of all the great men of the day, to which the paper on "Isothermal Lines" was presented, and by which it was printed, as all papers presented to it were, for private distribution. But from his intimate relations especially to the court of Prussia, some insinuations have been made as to the character of Humboldt. They are as unjust as they are severe in expression. He was never a flatterer of those in power. He has shown it by taking a prominent position, in 1848, at the head of those who accompanied the victims of the revolution of that year to

their last place of rest. But while he expressed his independence in such a manner, he had the kindliest feelings for all parties. He could not offend, even by an expression, those with whom he has been associated in early life; and I have no doubt that it is to that kindliness of feeling we must ascribe his somewhat indiscriminate patronage of aspirants in science, as well as men who were truly devoted to its highest aims. He may be said to have been, especially in his latter years, the friend of every cultivated man, wishing to lose no opportunity to do all the good of which he was capable; for he had a degree of benevolence and generosity which was unbounded. I can well say that there is not a man engaged in scientific investigation in Europe, who has not received at his hands marked tokens of his favor, and who is not under deep obligations to him. May I be permited to tell a circumstance which is personal to me in that respect, and which shows what he was capable of doing while he was forbiding an opportunity of telling it. I was only 24 years of age when in Paris, whither I had gone with means given to me by a friend; but was at last about to resign my studies from want of ability to meet my expenses. Professor Mitscherlich was then on a visit in Paris, and I had seen him in the morning, when he had asked me what was the cause of my depressed feelings; I told him that I had to go for I had nothing left. The next morning as I was seated at breakfast in front of the yard of the hotel where I lived, I saw the servant of Humboldt approach. He handed me a note, saying there was no answer and disappeared. I opened the note, and I see it now before me as distinctly as if I held the paper in my hand. It said:

"My friend, I hear that you intend leaving Paris in consequence of some embarrassment. That shall not be. I wish you to remain here as long as the object for which you came is not accomplished. I enclose you a check for £50. It is a loan which you may repay when you can."

Some years afterwards when I could have repaid him I wrote, asking for the privilege of remaining forever in his debt, knowing that this request would be more consonant to his feelings than the recovery of the money, and I am now in his debt. What he has done for me, I know he has done for many others; in silence and unknown to the world. I wish I could go on to state something more of his character, his conversational powers, &c., but I feel that I am not in a condition to speak of them. I would only say that his habits were very peculiar. He was an early riser, and yet he was seen at late hours in the saloons in different parts of Paris. From the year 1830 to 1848, while in Paris, he had been charged by the King of Prussia to send reports upon the condition of things there. He had before prepared for the King of Prussia a report on the political condition of the

Spanish Colonies in America, which no doubt had its influence afterwards upon the recognition of the independence of those colonies. The importance of such reports to the government of Prussia may be inferred from a perusal of his political and statistical essays upon Mexico and Cuba. It is a circumstance worth noticing that above all great powers Prussia has more distinguished, scientific and literary men among her diplomatists than any other State. And so was Humboldt actually a diplomatist in Paris though he was placed in that position, not from choice, but in consequence of the benevolence of the King, who wanted to give him an opportunity of being in Paris as often and as long as he chose.

But from that time there were two men in him,—the diplomatist, living in the Hotel des Princes, and the naturalist who roomed in the Rue de la Harpe, in a modest apartment in the second story; where his scientific friends had access to him every day before seven. After that he was frequently seen working in the library of the Institute until the time when the Grand Seigneur made his appearance at the court or in the saloons of Paris.

The influence he has exerted upon the progress of science is incalculable. I need only allude to the fact that the Cosmos, bringing every branch of natural science down to the comprehension of every class of students has been translated into the language of every civilized nation of the world, and gone through several editions. With him ends a great period in the history of science, a period to which Cuvier, Laplace, Arago, Gay-Lussac, Decandolle and Robert Brown belonged, and of whom only one is still living,—the venerable Biot.

Art. XIII.—*On the origin of Vibrio;* by H. James Clark of Cambridge, Mass.

(From the Proceedings of the American Academy, Boston, April 12, 1859.)

A few months ago a French physiologist, Pouchet, revived the long-exploded doctrine of equivocal or spontaneous generation, and asserted that he had been able to obtain certain living beings from substances which were entirely shut off from the outer world, and in which, after having undergone certain preparations, there could not possibly be any germs of these animals. A discovery, which I made on the 20th of March, may not be uninteresting, as it has more or less relations in its nature to the theory so earnestly advocated by Pouchet. There are certain well known bodies described as animals by Ehrenberg, under the name of Vibrio; their peculiarity consists in that they are

composed of a single row of globular bodies, resembling a string of beads, more or less curved, and move in a spiral path with great velocity, even faster than the eye can follow in many cases. They exhibit, by their activity, more plausible signs of animality than any of the Desmideæ or Diatomaceæ, and fully as convincing indications of life as the spores of Algæ, to which they were first referred by the late lamented Dr. W. I. Burnet, and after him by Rudolph Wagner and Leuckart. They have always been spoken of as developing around decaying animal and vegetable matter. I was very much surprised to discover the manner in which they orginate from such substances. I was studying the decomposing muscle of a Sagitta, a little crustacean, as I consider it,—which, in passing, I would observe was found by me a year ago last March, for the first time in this country, at Lynn Harbor,—when I noticed large numbers of Vibrio darting hither and thither, but most frequently swarming about the muscular fibres. I was struck with the similarity of these bead-like strings to the fibrillæ of the muscle, and upon close comparison I found that the former were exactly of the same size, and had the same optical properties as the latter. Some of these appeared to be attached to the ends of the flat, ribbon-like fibres, and others at times loosened themselves and swam away. I was immediately impressed with the daring thought, that these Vibrios were the fibrillæ set loose from the fibres; but as this was a thing unheard of, and so startling, I for the time persuaded myself that they must have been accidentally attached and subsequently loosened. However, I continued my observation until I found some fibres in which the fibrillæ were in all stages of decomposition. At one end of the fibre the ultimate cellules of the fibrillæ were so closely united, that only the longitudinal and transverse striæ were visible; further along, the cellules were singly visible, and still further they had assumed a globular shape; next, the transverse rows were loosened from each other excepting at one end; and finally, those at the extreme of the fibre were agitated and waved to and fro as if to get loose, which they did from time to time, and, assuming a curved form, revolved each upon its axis and swam away with amazing velocity. There was no doubting, after this, the identity of the Vibrios and the muscular fibrillæ; but I thought such a strange phenomenon ought to have a second witness to vouch for it, and therefore went for the best that could be wished for, Professor Agassiz. I simply placed the preparations before him, and, without giving him the least hint of the origin of the muscle, I was pleased to have him rediscover what I had seen but fifteen minutes before.

The number of ultimate cellules in a moving string varied from two to fifty; the greatest number of strings were composed

of only three or four, often six to eight, and rarely as high as fifty. Very rarely the fibres split longitudinally, and in such instances the fibrillæ were most frequently long, and moved about with undulations rather than a wriggling motion. A single ultimate cellule, when set loose, danced about in a zigzag manner; but whenever two were combined, the motion had a definite direction, which corresponded to the longer diameter of the duplicate combination; and if only three were combined, the spiral motion was the result of their united action. What it is that causes these cellules to move I do not profess to know, but certainly it is not because they possess life as independent beings. This much is settled, however, that we may have presented to us all the phenomena of life, as exhibited by the activity of the lowest forms of animals and plants, by the ultimate cellules of the decomposed and fetid striated muscle of a Sagitta. I do not pretend to say that everything that comes under the name of Vibrio or Spirillum is a decomposed muscle or other tissue, although I believe such will turn out to be the fact; but this much I will vouch for, and will call on Professor Agassiz to witness, that what would be declared, by competent authority, to be a living being, and accounted a certain species of Vibrio, is nothing but absolutely dead muscle.

ART. XIV.—*Biographical Sketch of Professor Denison Olmsted;* by Rev. C. S. LYMAN.

IT is with deep sadness that we record the death of Professor DENISON OLMSTED, for thirty-four years the honored incumbent of the chair of Natural Philosophy and Astronomy in Yale College. He died at his residence in New Haven, after a few weeks illness, on the 13th of May, 1859, in the sixty-eighth year of his age.

Besides this brief record, it is fitting that this Journal, to which Professor Olmsted has been a contributor from its commencement, should preserve, as a further tribute to his memory, such a sketch as our limits will permit of his career as a man of science. For a full analysis of his life and character in the several relations, public and private, which he was called to fill, we neither have room, nor is this the appropriate place. And such a presentation, we are happy to add, is rendered the more unnecessary by the very complete and admirable commemorative Address of Pres. Woolsey,* in which is given a just and discriminating estimate not only of Prof. Olmsted's scientific

* New Englander for August, 1859.

labors, but, more fully, of his successful career as an instructor, and of his well-balanced and exemplary character as a man and a christian in all the relations of life. It will be our purpose, therefore, in this sketch, to contemplate Prof. Olmsted, chiefly, as a teacher and cultivater of science.

He was born in East Hartford on the 18th of June, 1791,—the fourth child of Nathaniel Olmsted, a respectable farmer, who was a descendant of James Olmsted, one of the first settlers of the colony of Connecticut. His mother, a daughter of Denison Kingsbury of Andover, Ct., was a woman of most exemplary christian character, and to her (his father having died when he was about a year old) he was indebted for that excellent religious training, the fruits of which were exhibited in all his subsequent life, and for which she found herself rewarded, even to extreme old age, by a depth of affection and veneration on his part such as few mothers can inspire.

In Farmington, to which town his mother removed, on her second marriage, when he was about nine years old, he attended a district school for several winters, having his home for that purpose in the family of Gov. Treadwell. This excellent man, becoming interested in the boy for his amiability, intelligence, and other promising traits, took pains to instruct him privately during the long evenings, especially in arithmetic, which was not then taught in the common schools; and so befriended him, in this and other ways, that in after life Prof. Olmsted ever cherished his memory with the deepest affection and gratitude, and at a later period, embodied his estimate of his benefactor in an elaborate memoir, published in the American Quarterly Register for 1843.

At the age of sixteen, when he had been for some time employed in a country store, in which a son of Gov. Treadwell was one of the partners, he made up his mind to obtain a liberal education; and after pursuing his preparatory studies, first at an excellent school kept by James Morris at Litchfield South Farms, and afterwards under Rev. Noah Porter, pastor at that time, as now, of the church in Farmington, he entered Yale College in 1809, when Dr. Dwight, to whom he afterwards became strongly attached, and who exerted a very decided influence on his character, was in the zenith of his reputation and power. Young Olmsted was a diligent and successful scholar, and at his graduation in 1813, took the rank of an orator in a class of seventy, when only ten received that honor.

On leaving college, Mr. Olmsted became a teacher in New London, taking charge of the "Union School," so called,—a private institution for boys. In 1815 he was appointed to a tutorship in Yale College, and while filling this office, commenced the study of theology in a class instructed by Dr. Dwight, with

a view to entering the ministry. In about a year, however, his revered instructor was removed by death, and Mr. Olmsted evinced his affection for his memory by an appreciative memoir, which was published in the Port Folio for November, 1817. Meanwhile his experience and observation as a teacher, not only in college and in New London, but in Farmington also, where, at the age of seventeen, he taught a district school, appear to have awakened in his mind a deep interest in the subject of education, and a desire to make some effort for the improvement of the schools of his native state. In an oration "on the state of education in Connecticut," which he delivered in 1816 on taking his Master's degree, he sketched the outlines of a plan, original with himself, of what he termed a "seminary for schoolmasters," to be supported by the State;—an idea since so happily realized in our Normal Schools.

But his aims in this direction were terminated, as well as his theological studies, by his appointment in 1817 to the chair of Chemistry in the University of North Carolina, upon the duties of which he entered after a year spent at New Haven in special preparation under the private instruction of Prof. Silliman. At Chapel Hill he not only discharged successfully the duties of his professorship, (which, besides chemistry, then included, as in most other colleges, mineralogy and geology,) but, during his residence there, he was also employed by the State to make a survey of its geology and mineral resources;—a circumstance the more worthy of notice, as this was the first enterprize of the sort accomplished under the auspices and at the expense of any of the States. The project was first laid by Prof. Olmsted, in 1821, before the Board of Internal Improvements, with the offer to perform the entire work himself, gratuitously, and the modest suggestion of an appropriation by the Board of "*one hundred dollars,* to be afterwards renewed or not at the pleasure of the Board," to defray his necessary expenses in traveling. This proposition, however, the Board declined, and the survey was afterwards made under the direction of the State Board of Agriculture. To this Board Prof. Olmsted addressed his Report, which was published in two parts, in 1824 and 1825, filling in all about 140 pages octavo; so unpretending was the prototype of the numerous and ponderous volumes of scientific research which have since been published by so many of the States. This survey, regarded especially as the gratuitous vacation-work of a single individual, and in view of the state of geological science in this country at the time, must certainly be looked upon as creditable in the highest degree both to the enterprise and the scientific ability of its projector; and it has undoubtedly been of great benefit, not only to the State which authorized it, but to the country and to science generally, by the stimulus which

it afforded to similar enterprises in other States. Prof. Olmsted gave the first geological description of the Deep River Coal Field, and of the Red Sandstone accompanying; and referred the strata correctly to the same age with that of the Richmond coal beds and the Connecticut River Sandstone.

While at Chapel Hill, Prof. Olmsted also began researches to determine the practicability of obtaining illuminating gas from cotton-seed—a waste material so abundant in cotton-growing districts as to be an important product of agriculture if capable of being put to any valuable use.

These researches, however, were broken off, as well as his further cultivation of chemistry and geology, by his call, in 1825, to the professorship of Mathematics and Natural Philosophy in Yale College, left vacant by the death of Prof. Matthew R. Dutton, who himself, only three years before, had succeeded the lamented Fisher, Prof. Olmsted's classmate and intimate friend, whose brief but brilliant mathematical career was so sadly terminated by shipwreck in 1822, when on his way to Europe for the purpose of study.

Prof. Olmsted came to this new chair, it will be noticed, after he had spent some of his best years in one requiring attainments and mental culture of a widely different cast. But though lacking somewhat, as he was himself aware, in that special preparation which a devotion of those years to the higher mathematics and the more abstruse investigation of physics might have given him, he nevertheless applied himself with such zeal to his new duties as to overcome in great measure the difficulties he encountered, and approve himself a successful instructor in the branches committed to his care. The department of mathematics, however, in accordance with his own wishes, was in 1835 made a separate chair, and assigned to the able and promising, but short-lived Prof. Anthony D. Stanley, while Prof. Olmsted retained his favorite branches of natural philosophy and astronomy. In these he continued to give instruction down to his last illness, a period in all of thirty-four years.

When he came to New Haven he discovered a sad want of suitable text-books in his department. Enfield's Philosophy, which had held its place in our colleges for many years, was full of inaccuracies and far behind the existing state of science. And the series of text-books then recently prepared by Prof. Farrar of Cambridge, chiefly translations from French authors, were, besides other objections, both too extensive and too difficult for the majority of American students at that period. This recognized want Prof. Olmsted successfully met by the preparation of his larger work on Natural Philosophy, which was first published in 1831, in two volumes octavo. This work, though in parts professedly a compilation or abridgment, as in mechanics,

from the treatise of Bridge, and though excluding the higher mathematics, which were not then taught in our colleges, is yet characterized by so many excellencies of form and arrangement, and on the whole is so well adapted to the wants of the great majority of students, that it has from the first been received with favor by the public, and having passed through many editions, continues to be very extensively used in the colleges of the United States. If the rapid progress of research and discovery since its first publication has rendered some changes necessary to adapt it to the present state of science and to the higher standard of education in our colleges, a new and thorough revision of the whole work, which its author was about to enter upon at the time of his death in connection with Prof. Snell of Amherst and Prof. Newton of Yale College, and which, it is understood, these gentlemen are now carrying forward, will be likely to render it as acceptable hereafter as it proved to be when originally published.

An abridgment of this work, called the "School Philosophy," was published in 1832, for the use of high schools and academies, and has already, it is said, passed through more than a hundred editions. A still smaller work, entitled "Rudiments of Natural Philosophy and Astronomy," was issued in 1842, and is adapted to pupils in elementary schools. This little work has gone through some fifty editions, and on account of its clearness and comprehensiveness, has been adopted as the text-book on these subjects for use in institutions for the blind, an edition for this purpose having been printed in raised letters, in large quarto form, as early as 1845.

Prof. Olmsted's text-book of Astronomy for colleges was published in 1839 in one volume octavo. It is characterized, in the main, by the same qualities as his other books, and has found general favor, it is believed, among the teachers of that science. An abridgment for schools was published soon after the original work. Still another book on the same science, called "Letters on Astronomy," purporting to have been written to a lady, was prepared by Prof. Olmsted as a reading book at the request of the Massachusetts Board of Education, and published in 1842.

Besides instructing in astronomy by text-book, Prof. Olmsted delivered annually to the two upper classes in college three courses of lectures, one on natural philosophy and optics, one on astronomy, and another on meteorology. These he prepared with much labor, and by frequent revision, endeavored to adapt to the rapid progress of scientific discovery. They were characterized by fullness, clearness and method, and sometimes by eloquence. The course on meteorology was, perhaps, on the whole, the most attractive and useful.

In the subjects of storms, auroras, and shooting-stars, he took special interest. A new theory of Hail-storms was published

by him, in 1830, in the American Journal of Science,—ascribing their origin to the sudden mingling of large bodies of hot and humid air with air extremely cold, by which the vapor of the former would be rapidly condensed and congealed into hail; which effect would be produced whenever, by means of opposing winds, whirlwinds, or other atmospheric disturbance, hot air should be carried above the line of congelation or cold air brought below it. This hypothesis, though it has never obtained the celebrity of the ingenious, but improbable, electrical theory of Volta, is yet, perhaps, as plausible as any, or at least is sufficiently so to warrant its author in his steady adherence to it, especially if we consider that such is the intrinsic difficulty of the subject as to compel the acutest physicists to confess that no satisfactory theory has yet been proposed,—hailstorms being characterized by Pouillet as among the most formidable of scourges to agriculture, and the most perplexing of phenomena to meteorologists.

In respect to the great storms of our Atlantic coast, and similar ones elsewhere, he adopted in the main, the rotary theory of Mr. Wm. C. Redfield, whom he early encouraged in the development of his views on this subject, and for whom he cherished a sincere attachment, which led him, after the death of his friend, to prepare the eulogium which he delivered before the American Association for the Advancement of Science, at its meeting in Montreal. In this address Prof. Olmsted thus defines his own position in respect to Mr. Redfield's views. "While from the first I have heartily embraced Redfield's doctrine that ocean gales are progressive whirlwinds, and have further fully believed that he had established their laws or modes of action on an impregnable basis, a regard to truth and candor obliges me to say, that I have never been a convert to his views respecting the ultimate causes of storms, especially so far as he assigned for these causes what he denominates the 'diurnal and orbitual motions of the earth,' but his notions on this point have always appeared to me unsatisfactory."

The phenomena of the northern lights, such remarkable exhibitions of which occurred in 1835 and 1837, were watched by Prof. Olmsted with intense interest, and one of his latest and most elaborate memoirs is that "On the Secular Period of the Aurora Borealis," published in 1856, in the eighth volume of the Smithsonian Contributions. In this paper, rejecting the electrical and magnetic hypotheses, and others which ascribe the origin of the aurora to terrestrial causes, he advocated the doctrine of their cosmical origin, deriving their materials from some supposed nebulous body traversing the planetary spaces, and assigning to the phenomena a secular period of about sixty or sixty-five years. This view, it must be acknowledged, has

found, as yet, little favor among men of science. But, whether it prove ultimately to have any foundation in truth or not, Prof. Olmsted deserves very great credit for the unwearied diligence with which he has collected and recorded the facts, and for the earnestness with which he has called the attention of philosophers to this most interesting problem in physics.

But Prof. Olmsted is most widely and favorably known to the scientific world by his papers, published chiefly in the Journal of Science for 1834, on "meteoric showers," or showers of shooting stars. His interest in the subject was first awakened, like that of many others, by the very remarkable phenomena of the morning of November 13th, 1833, when, in all parts of the United States, myriads of these meteors, especially between the hours of two and five o'clock, were seen falling in a brilliant and continuous shower through the heavens. Prof. Olmsted saw this magnificent display, indeed, not in its maximum grandeur, but only the portion of it which occurred after half past five o'clock, when his attention was first called to it by a friend. Yet observing it with the eye of a philosopher, he noted with care its most important features, and collecting at once all the observations he could obtain from various quarters, he made a careful classification and analysis of the facts, which he presented in two successive numbers of the American Journal of Science for 1834.* While preparing this paper he was led to entertain the idea that these meteors had a cosmical rather than a terrestrial or atmospheric origin, and at the close of his article, stated it as his general conclusion, "That the meteors of Nov. 13th consisted of portions of the extreme parts of a nebulous body, which revolves around the sun in an orbit interior to that of the earth, but little inclined to the plane of the ecliptic, having its aphelion near to the earth's path, and having a periodic time of 182 days, nearly."

Prof. A. C. Twining, then at West Point, from his own and other independent observations, arrived substantially at some of the same conclusions, especially in respect to the cosmical origin of the meteors, though apparently with a less degree of confidence, as appears from his own candid remark in his very able article on the subject in the twenty-sixth volume of the Journal of Science, "That he is not able, as yet, to adopt even his own inferences respecting the cause, in any other way than as *conjectural and highly credible.*" Both he and Prof. Olmsted, however, clearly recognized the leading fact, which was decisive of the question of cosmical origin, namely, the identity of the point of apparent radiation of the meteors with the point in the heavens towards which the earth was then moving in its orbit, and the names of both must consequently be associated, in the minds of those who read their articles, with the theory which both so essentially contributed to establish.

* Vol. xxv, No. 2, and Vol. xxvi, No. 1.

Prof. Olmsted, however, has from the first been chiefly associated in the public mind with this theory of meteors,—partly, perhaps, from the greater confidence and fullness of explanation with which he propounded it, and partly from his prominent position before the public in an important chair of science. The theory, indeed, in the precise form in which he originally stated it, has never in all its details obtained general currency, and was even for a time wholly rejected or regarded with much incredulity by many distinguished men of science, yet in its leading features of cosmical origin and periodicity he had the satisfaction of seeing it remain unshaken, and receive the approbation and support of the leading physicists of the day. A broader generalization of facts, especially those gathered by Mr. E. C. Herrick, from the records of meteors in preceding ages, soon brought to light other annual periods of their return besides that of November, particularly those of April, August and December. This modification, however, did not affect the main point of the hypothesis.

It has been said, indeed, that Prof. Olmsted was anticipated in this theory by Chladni; and Humboldt, who in several passages of the Cosmos, speaks of the researches of Prof. Olmsted in complimentary terms, refers to them in one place, not as having originated the hypothesis, but as "a brilliant confirmation of the cosmical origin of these phenomena,"* ascribing to Chladni the credit of the theory itself. But besides the fact that, so far as appears, the cosmical hypothesis of Chladni pertained especially to aerolites and their associated fireballs, and did not definitely include showers of shooting stars, and the further fact, that the idea of the cosmical origin of this whole class of meteors had been suggested in general terms by many other philosophers even including Anaxagoras, we may remark, without claiming for Prof. Olmsted the merit of priority, that his conclusions were unquestionably original with himself, and entirely independent of any results of preceding investigations. Whatever form in respect to its details, the theory may assume in the light of future researches, to Prof. Olmsted clearly belongs the merit of having discerned and demonstrated its leading truth, and he deserves for what he has done, all the credit that has been accorded to him by European savans. Humboldt, Biot, Olbers, Encke, and others, adopting substantially the same views, have fully recognized his merits and spoken of his investigations in complimentary terms.

Prof. Olmsted gave much attention also to the subject of the zodiacal light, and in papers published in the Journal of Science and in the Proceedings of the American Association, has endeavored to establish an identity between its source and that of the November meteors. The same idea has received the sanction

* Cosmos, vol. i, p. 118, Harper.

and support, also, of M. Biot, who assigns to Prof. Olmsted the credit of its authorship.

It will be seen, from the brief account we have given, that Prof. Olmsted was inclined to adopt theories very similar to each other, to explain the phenomena of shooting stars, of auroras, and of the zodiacal light—if not, indeed, to ascribe them all to one and the same origin. But if, in the case of auroras or the zodiacal light, his speculations shall fail to be confirmed, it must be remembered that they were for the most part thrown out by him only as conjectures, and that he himself disclaimed holding his theory of meteors at all responsible for their soundness; and furthermore, that it is a thing by no means of rare occurrence among men of science that a successful theorizer has been tempted by success to stretch the application of his theory beyond its legitimate limits.

The want of a proper observatory and of suitable instruments at New Haven, prevented Prof. Olmsted from giving to practical astronomy as much attention as he might otherwise have done. Of the Clark telescope, however, at that time the best in the country, he made as good use as his other engagements and the wretched position of the instrument would allow, in showing to his pupils such celestial phenomena as admitted of simple inspection; and with this instrument in 1835, he, with Prof. Elias Loomis, then a tutor in the College, succeeded first of American observers in obtaining a view of Halley's comet, then so anxiously looked for both in this country and in Europe. This deficiency of astronomical instruments Prof. Olmsted was always anxious to remove, and at various times efforts were commenced, in which he zealously participated, to establish an observatory. But many difficulties arose from time to time, especially in the matter of raising funds, and he never enjoyed the satisfaction of seeing so desirable an object accomplished.

In teaching science, Prof. Olmsted by no means restricted himself to theoretical instruction, but, both in the lecture-room and in popular articles and addresses, endeavored to render science attractive and useful to all, by pointing out its practical applications. He gave much attention to the means of protecting houses from lightning, the warming and ventilation of buildings, and other like practical problems, as they were brought to his notice, frequently contributing articles on such topics to the papers of the day, and often, on the occurrence of any special phenomena coming within the range of his department of science, favoring the public with an appropriate discourse. He was the inventor of an excellent stove which bore his name, the patent for which became to him at first, it is understood, a source of some pecuniary profit, at a time when his insufficient salary rendered an increase of income particularly acceptable, but afterwards, from

causes not connected with its merits, ceased to be remunerative. A useful preparation of lard and rosin for lubricating machinery was also invented by him some years ago, but never patented, and it has since, it is said, become an article of successful manufacture.

In forming our estimate, on the whole, of Prof. Olmsted's scientific character, we must bear in mind that he himself always regarded it as his more appropriate sphere of effort, in the circumstances in which he was placed, not so much to *cultivate* science as to *teach* and *diffuse* it. Teaching, indeed, was his chosen and ever-cherished work, and the one for which by temperament, talents, training and attainments, he was peculiarly fitted. His uniform kindness and courtesy of demeanor, and patience in imparting instruction—the excellent moral influence which he always exerted as well by his consistent christian example as by his personal counsels—the genuine friendliness of his disposition, and the unaffected interest which he always manifested in the welfare of his pupils—especially the readiness and fidelity with which he encouraged and assisted any who exhibited special fondness for the studies of his department—will not soon be forgotten by those who enjoyed the benefit of his instructions, and especially by those who were admitted to his closer friendship. Ebenezer Porter Mason was a pupil whose brilliant and versatile talents, and especially his rare attainments and promise in mathematics and astronomy, awakened in his instructor at once the liveliest and most affectionate interest; and on the death of this remarkable genius at the early age of twenty-two, Prof. Olmsted paid a tribute not less to his own kindness of heart than to the memory of his friend, in writing the excellent memoir of his life which was published in a duodecimo volume in 1842.

Besides the writings which have been named, Prof. Olmsted published, at different times, many elaborate articles of a scientific or literary character, in the leading periodicals of the day, particularly the American Journal of Science and the New Englander. He was especially fond of biographical composition, and his memoirs of Dr. Dwight, Sir Humphry Davy, Gov. Treadwell, Eli Whitney and Wm. C. Redfield, may be mentioned as favorable examples.

In the later years of his life, Prof. Olmsted saw much affliction. Besides his first wife, four sons, grown to manhood, graduates of college, and giving fine promise of usefulness and distinction in literature or science, were one after another taken from him, —filling his home with grief yet not destroying his cheerfulness or composure of mind. But he has now gone to his rest, and not alone his remaining family, but the wide circle of his friends and former pupils will cherish with deep affection his honored memory.

Art. XV.—*Correspondence of Prof. Jerome Nicklès of Nancy, France, dated April 17th*, 1859.

Academy of Sciences.—Distribution of Prizes.—On the 14th of last March the Academy of Sciences held its annual public meeting. We have more than once spoken of these annual sessions and shown them to be generally void of result, a fact for which the Academy itself, which accomplishes so poorly its mission, is to blame. It has been this year as in preceding years, and we are compelled to repeat the truth: if we were to judge of the progress of science by the prizes awarded, we should infer that nothing new had been accomplished in the departments of mathematics, mechanics, physics, chemistry, geology, mineralogy, botany, &c.,—we could almost say in all departments of experimental science. Happily it is not so, and our readers have been able to judge by our correspondence for the years 1857 and 1858, that in Europe as in America, men of science have well employed their time and their strength to the great advantage of science and humanity.

Astronomical Prize.—The only section which every year awards a prize, is that of astronomy, in behalf of which the astronomer Lalande established a fund for the purpose of granting a medal to the person who in France, or elsewhere (the members of the Institute excepted), should have made the most important observation or prepared a treatise or work contributing most highly to the progress of the science. Not willing to pronounce on this latter point, the Academy has divided the prize between MM. Goldschmidt of Paris, Laurent of Nismes, Searle of the Observatory at Albany, N. Y., Tuttle of Cambridge, Mass., Winnecke of Bonn, and Donati of Florence. The following is an extract from the report.

The planet Nemausa was discovered on the 22d of January at Nismes by Mr. Laurent, and the planet Pandora on the 10th of September by Mr. George Searle, assistant in the Observatory at Albany in America. The names of these two savans are now inscribed for the first time in the list of observers who, within a dozen years, have enriched astronomy by discoveries of asteroids.

The planet Calypso, discovered on the 4th of April at the observatory of Bilk by Mr. Luther, is the seventh the knowledge of which is due to this skilful astronomer.

The two planets, Europa and Alexandra, were discovered at Paris the 4th of February, and the 10th of September by Mr. Goldschmidt, that successful explorer of the skies, who, without having to meet the ordinary responsibilities of an astronomer, devotes himself continually, through love for science, to the most laborious researches. It was at first thought that he had rediscovered, on the 9th of September, 1857, the planet Daphne; but Mr. Schubert of Berlin soon showed this to be a mistake, proving that the planet was a new one. This planet, which by the date of its discovery is the 47th of the group, increases to *twelve* the number made known by Mr. Goldschmidt.

Among the comets of the year 1858, there are two whose periodicity is well established, and one that presented during its long and brilliant

display phenomena of great interest bearing on the physical theory of comets.

Of the three comets discovered at Cambridge in America by Mr. Tuttle, the first on the 4th of January, the third on the 2d of May, and the sixth on the 5th of September, the first is of peculiar interest, as its elements are recognized as identical with those of the second comet of 1790 discovered by Méchain. Mr. Bruhns of Berlin, who discovered this comet seven days after Mr. Tuttle, has compared a great number of observations made up to the month of March in Europe and in America, and has deduced from them an elliptical orbit of 13·66 years. The comet discovered on the 4th of January by Mr. Tuttle has therefore returned four times since 1790 without having been seen.

Statistical Prize.—Of a number of prizes for statistics we notice an "honorable mention" decreed to Mr. Bérigny of Versailles for a work on the question, "Is there any connection between germination and the changes of the moon, or between its phases and human generation?" This statistical treatise contains a list of 30,958 births according to the civil state-registers of Versailles, and extending over forty years. The results are negative; that is to say, on the authority of the civil register of Versailles it can be declared that the moon does not possess, like the sun, the privilege of influencing the march of human generations.

Prize for Experimental Physiology.—The great prize for Experimental Physiology was awarded to Mr. Jacubowitch for his treatise on the *Internal structure of the brain, and on the spinal cord of man and animals.* According to the statement of the commission this work contains results of great importance to histology, physiology, and comparative anatomy. The report made by Mr. Claude Bernard concludes thus. "In recapitulation, Mr. Jacubowitch has taken up one of the most difficult problems in physiology and anatomy, that of the texture of the nervous system and of the different constituent elements with reference to determining their physiological importance. This author has recognized and described three peculiar forms of nervous cellules in their relations to one another and to three kinds of nervous fibres. He has determined the exact arrangement of these nervous histological elements in the spinal cord, the medulla oblongata, and the brain; he has indicated the points of the nervous centres in which these cellules or fibres group themselves, accumulate, mingle, separate, appear or disappear. These anatomical researches, made not only in man but also in four classes of vertebrate animals, are of great importance to physiology."

A second prize for Experimental Physiology was divided between Mr. Leuhossek of Warsaw and Mr. Lacaze-Duthiers, Professor in the faculty of sciences at Lille; the first for his "Etudes Anatomiques" on the central nervous system. These are researches in microscopic anatomy having numerous relations to physiology. The method employed by Mr. Leuhossek in his researches is the method of slices in different directions; the parts of the nervous system were not hardened by chromic acid, but only by alcohol, and the slices were rendered transparent either by acetic acid or some other convenient substance.

The labors of Mr. Lacaze-Duthiers have contributed largely to the progress of most of the branches in the history of acephalous mollusks;

the commission has bestowed its attention principally on the experiments and observations of this naturalist relating 1st, to the circulation of the nourishing fluids in the Dentalia; 2d, to the developments of the respiratory apparatus in mussels (Mytili); and 3d, to the structure of the urinary glands and the organs of generation of a considerable number of other mollusks.

The Bréant Prize.—We have already several times spoken of the prize of 100,000 francs instituted by Mr. Bréant in favor of the person who should discover a mode of medical treatment which would cure the cholera in the majority of cases, or who should point out satisfactorily the causes of Asiatic cholera so that by removing these causes, an end would be put to the epidemic; or lastly, to the person who should discover a certain preventive of it, as evident, for example, as that of vaccination for small-pox.

Foreseeing that this prize of 100,000 fr. would not be awarded very soon, Mr. Bréant grants the interest of this sum to the person who shall have promoted the progress of science as regards the cholera or any other epidemic malady.

This year the Academy of Sciences awarded a prize of 5000 fr. to Léon Doyère for his experiments on the composition of the air expired by victims of the cholera, and the temperature of the body of these patients during the last moments of life. Mr. Doyère has proved the following points: 1st, the more severe the attack of cholera, the larger the amount of oxygen in the air expired; 2d, the proportion of carbonic acid thrown out by cholera patients is very inconsiderable; 3d, notwithstanding the diminution of the activity of the respiratory functions, the temperature of the body increases till it reaches the point of 43° C. (110° F.) in the region of the armpit.

It is but justice to state that of these three results, the first was announced in 1832 by Mr. Rayer; the last was proved in 1830 by the French physicians who went into Poland to study the cholera; and it was afterwards verified in England and in the United States.

Moreover neither the second nor the third facts are peculiar to the victims of cholera. As for the second, Dr. Malcolm demonstrated in 1844, that in typhus fever a less quantity of carbonic acid escapes from the lungs than in the normal state of the body, and furthermore, Mr. Doyère has observed the same fact in respect to persons affected with typhoid fever and with acute pneumonia. As far as concerns the latter fact, many authors have noticed a rise of temperature in the last stages of scarlet and yellow fever, as in cases of cholera, and Mr. Doyère has seen the same thing in typhoid fever.

Discussion upon the nature of simple bodies.—The discussion mentioned in our last communication, and which was started by a paper read by Mr. Despretz, has since been renewed, and it has been watched with the utmost interest by all who are engaged in the physical sciences. Doubtless it has not changed the opinion of either Despretz or Dumas; and this is well for the latter chemist at least, for all competent observers regard Dumas as representing in this case the cause of progress.

While the discussion has been useless in this—that it has only brought out ideas which have been current in science, and in the elaboration of

which Dumas has had so large a share, it has had an important scientific bearing, since it has contributed to the establishment of these very ideas, and has compelled Dumas to put in a precise form his scientific opinions on the unity of matter and the intimate nature of simple bodies.

We give a brief notice of the discussion, as it is one which will without doubt leave its trace on the records of science.

Dumas having declared that the experiments which Despretz had just published were neither necessary in the actual state of science, nor yet decisive, Despretz replied in his turn, criticizing the ideas of Dumas on the unity of matter. According to him there is not a sufficient analogy between the radicals of organic chemistry and the simple bodies of mineral chemistry. The first are decomposed by heat, and converted by oxygen into water and carbonic acid. These organic compounds thus disunited can never be again re-composed. It is well understood to be quite otherwise in respect to the elements of mineral chemistry. From this Mr. Despretz concluded that there is not only no analogy, but that there is a complete contrariety, between the elements of organic and inorganic chemistry; in a word, as far as he can discern, science furnishes no indication favoring a belief in the decomposition of the bodies considered simple, even by the aid of new forces. On the contrary he thinks he has demonstrated that the metals and metalloids are simple bodies. We have already seen by what processes he thinks he has arrived at this conclusion: he returns to the subject now to show in what respect his experiments are new, and says: "all chemists have ignited iron and platinum to a white heat, but no chemist to our knowledge has ignited these metals in a barometric vacuum for the purpose of ascertaining whether any gas was disengaged; and this is my experiment."

"Nothing is disengaged under the action of heat, or of a spark from a powerful induction apparatus. This negative result is of a nature to astonish the partisans of the theory of Dr. Prout, if any exist. According to this hypothesis, iron should retain about 80,000 and platinum 200,000 volumes of hydrogen gas condensed into only one volume. How can we suppose that a condensed gas could resist the test to which iron and platinum are subjected in my experiment? Is there a single fact in physics and in chemistry which authorizes such a supposition? In my process the disengagement of $\frac{1}{20}$th of a cubic centimetre of gas would have been readily appreciable. To this slight weight the most delicate chemical balances would have been insensible."

The reply of Dumas is briefly as follows: "I demand of Mr. Despretz why he expects the metals to resolve themselves into gas? why is it necessary that the primary elements of bodies should be gaseous? As regards the analogies between organic and inorganic chemistry, which are denied by Mr. Despretz, I ask where is the chemist who would not unite in one group cyanogen and chlorine, bromine and iodine? Where are the differences between these two sets of substances? Do they not blend in all their chemical affinities? Does not the analogy between them extend even to a similarity of atomic volumes? It is true cyanogen has been decomposed while the others have resisted decomposition; but he is greatly mistaken who believes that the discovery of cyanogen did not suggest doubts to the minds of chemists, and to Gay Lussac himself, on the nature of chlorine."

"Is not the same the case with ammonium and the radicals of the ethers? Do not these radicals furnish oxyds, chlorids, sulphurets? Do not their oxyds, acting the part of bases, resemble potassa and soda so strongly as even to mislead? Have we not in the combinations of these radicals the same system as in inorganic chemistry? Who is the chemist to whom these discoveries succeeding one upon another, have not suggested doubts concerning the nature of the metals?"

"In a word, the efforts of modern chemists for forty years, efforts without parallel from the first beginning of chemistry as a science, in which so much perseverance and so much courage have been expended, have resulted in proving that organic chemistry is made up of substances which are subject to the very same laws with which Lavoisier enchained inorganic chemistry, and subordinated to the same scheme through all its products." It was Lavoisier who, on tracing out the route for us to follow, more than seventy years since, defined organic chemistry as the chemistry of *compound radicals*, and mineral chemistry the chemistry of undecomposable radicals."

Dumas then refuted one after another the facts brought forward by his antagonist in proof of his view. "If Mr. Despretz thinks that by distilling mercury, zinc, or cadmium, these substances can be decomposed, he forgets that alchemists and the arts long ago threw light on this point. If he confounds with the decomposition of a simple body the analysis of a mixture, I regret it, but I remain convinced that there is not the slightest connection between the successive separations and the decomposition of simple bodies; that there is nothing in common between those fortunate concentrations to which we owe the discovery of iodine, cadmium, selenium and bromine, and a philosophical discussion concerning the principle of the unity of matter."

Dumas presented the following conclusions: "1st. It appears to me more and more probable that the equivalents of simple bodies are multiples of the same unit; 2d, that the radicals of mineral chemistry behave in the same way as the radicals of organic chemistry; 3d, that it is impossible to prove that bodies reputed simple are undecomposable; 4th, that if, even at the present time, simply by employing forces and means already known, it is easy to contrive processes more powerful than those which Mr. Despretz has employed for the purpose of accomplishing this decomposition, I regard it as my duty to affirm anew that in my opinion these processes, though more rational, will not probably be more effectual."

Discussion on cellulose and ligneous fibre.—While this discussion on the question of simple bodies, of which we have spoken, was being carried on, and that concerning spontaneous generation so spiritedly agitated even to this present hour (see our last communication), another important question was handled before the Academy of Sciences; it was concerning the probability of the existence of only one, or of several kinds, of cellulose. Payen was an advocate of the first opinion, Fremy of the second. Judging from the action produced upon ligneous tissues by Schweitzer's reagent (see our last communication but one), Fremy admits at least two species of cellulose, for he has seen paper and textile fibres in general dissolve in ammoniacal oxyd of copper, while elder-pith and ligneous fibre in general resist its action.

To Mr. Payen this difference seemed only an apparent one; he believed that in this latter case, the cellulose is incrusted with gum and foreign matters which hinder the solubility; also the pith of the elder which is insoluble in Schweitzer's reagent, becomes soluble in it when it has been previously treated with a weak acid such as dilute chlorohydric acid. Mr. Fremy supposed that the chlorohydric acid does not act as a solvent of foreign matters, but that it converts one variety of cellulose into the other variety, in the same way, for instance, as an acid converts cane sugar into glucose.

We need not speak of the different phases of this discussion, for it is not yet settled. According to Fremy, we must admit at least two kinds of cellulose offering the same percentage composition but differing from each other in their chemical properties and capable of being brought into the same state by the most diverse reagents, such as mineral acids, organic acids, potassa, ammonia, etc. In order to prove that the differences in the properties of cellulose are due to the state of the organic substance itself and not to the presence of mineral substances, Fremy has had recourse to the action of heat. In exposing vegetable pith, which is insoluble in the cupreous reagent, to the action of a temperature not exceeding 30°, and maintaining it at that point for several hours, he has seen that substance become soluble in the above reagent. He arrived at an analogous result by keeping the cellular tissue of pith for twenty-four hours in boiling water.

Furthermore, he has remarked that this change takes place only in the organic substance of the tissue, for the proportion of mineral matter remained the same in both cases, and the tissue which had become soluble in the cupreous reagent, left after its calcination a mineral network, reproducing exactly the form of the vegetable cellules, which same thing happens to tissues not modified by either dry or humid heat.

In order to distinguish between these two kinds of cellulose, Fremy calls *para-cellulose* that which *does not dissolve immediately* in the cupreous reagent. He reserves the name cellulose for that which *dissolves directly without previous treatment. Cellulose* is found in cotton, fibres of bark, cellular tissue of fruits or of roots. *Para-cellulose* constitutes principally the pith of trees, ligneous fibre, the cellular tissue of the epidermis, &c.

This is not Payen's opinion; the experiment of Fremy, quoted above, does not appear to him to prove that the pith of the elder is of an isomeric composition with the cellulose of textile fibres; for in Payen's view it is not only the fact that foreign substances in the form of incrustations oppose the solution of the cellulose in Schweitzer's reagents, but infinitely minute bubbles of air which are condensed there have the same effect to a certain point, in forming a protective envelop; according to him the pith of the Æschynomene, insoluble in Schweitzer's reagent, becomes soluble in it by keeping it in a vacuum in the cold under an exhausted receiver and afterwards plunging it under water; the liquid is then placed in a refrigerating mixture. After congealing, the pith has become to a great extent soluble; there remains a residue of 43 per cent containing 15 per cent of mineral substances. These mineral substances according to Payen prevent the complete solution of the cellulose. The

same is the case with cortical fibres before their purification; so also hemp just obtained from the flax-plant resisted solution for more than six hours, and the portions not dissolved preserved their fibrous form.

Incrusting matter; Dead cotton.—All these questions have recalled attention to an old paper by Mitscherlich on the composition of vegetable cellules, cellules essentially formed of cellulose, and of a substance analogous to cork, a suberic material capable of yielding suberic acid and also succinic and nitric acids. The most delicate vegetable fibres are covered over with this slender coating of suberic matter; it is on this account that fresh cotton is with difficulty moistened with water, while it is at once decomposed if this coating of suberic matter is removed by the action of chlorine.

Such at least is the opinion of Mitscherlich. It seems however that an immersion in chlorine is not always sufficient to render this variety of cotton capable of receiving color,—the variety perfectly well known among dyers, who have named it "dead cotton;" it was first described by Daniel Koechlin of Mulhouse, and has since been carefully studied by Walter Crum of Glasgow, whose results are published in the third volume of the Proceedings of the Philosophical Society of Glasgow.

In the opinion of Mr. Walter Crum the dyeing of cotton depends upon a purely mechanical action; chemistry is completely foreign to the subject of fixing dyes upon stuffs; dead cotton is the proof of this; the fibres of this variety of cotton are flattened, while cotton which admits of being dyed is composed of cylindrical fibres; the coloring matter hence can penetrate within these and fix itself there.

This is, as is seen, an opinion diametrically opposite to that of Runge, who is so strong an advocate of the chemical theory that he considers colored cottons as *cottonates;* in this view a faint chamois tint produced by oxyds of iron is called by him *per-cottonate* of iron; another *bi-cottonate;* another still *basic cottonate* of iron.

Mr. Walter Crum declares that the substance of dead cotton has been entirely bleached before becoming flattened; it contains therefore, he says, neither fatty matter nor any impurity capable of hindering the fixing of the coloring matter.

But let us return to the suberic matter whose presence Mitscherlich recognized on leaves and about the exterior of plants. It is over thirty years since Payen showed that the epidermis of plants is covered over with a very thin envelop, containing a fatty matter, some nitrogen and silica. Ad. Brongniart has isolated this pellicle, on which Mitscherlich experimented, by submitting leaves to a prolonged maceration, and has described it under the name of cuticle; and Frémy, who has also just examined it, has recognized in it all the characteristics of a fatty substance which he calls *cutine.* In fact, in contact with boiling potassa, the cutine saponifies and the acid which is produced presents the characters of a fatty acid. This experiment has been repeated with success on the epidermic membranes of leaves, flowers and fruits.

It is easy to develop, ad libitum, this epidermic membrane; it is sufficient, in fact, to experiment on superficial sections of living tissues of leaves, branches, tuberaceous roots, and subterranean stems; at the end of several days the denuded tissues afford characteristic reactions ef epidermic membranes.

Transformation of woody fibre into Sugar.—On the occasion of the above discussion Pelouze announced the important results which follow. Cellulose precipitated from its solution in ammoniacal oxyd of copper by a feeble acid, is soluble in dilute chlorohydric acid. Ordinary cellulose is soluble in concentrated chlorohydric acid; water forms with this solution a precipitate of dazzling whiteness; at the end of two days the precipitate ceases to form, and all the cellulose has been transformed into sugar affording the characteristics of glucose.

The transformation of cellulose into glucose can be effected by a prolonged ebullition in water containing a small quantity of sulphuric or chlorohydric acid (some hundredths); paper, old linen, sawdust, and any cellulose more or less pure, can be thus turned into sugar at the end of several hours boiling.

Pelouze thinks that this reaction will become the basis of a new branch of industry—one which has often been attempted since Braconnot succeeded in 1819 in transforming lignine into glucose; he thinks that the transformation would be rendered much more active by operating in a close vessel at an elevated temperature.

Lastly, Pelouze announces that, by treating cellulose with caustic potassa in fusion at a temperature between 150° and 190° C. and dissolving the product in water, a substance can be separated from it by acids which has the composition of cellulose, but differs from it in that it is soluble in the cold in alkalies; it changes into sugar in the presence of chlorohydric acid.

Manufacture of Aluminium.—This manufacture, which is becoming more and more extended, has just taken two steps onward; one, through the publication by H. St. Claire Deville, of a treatise expressly on the subject; the other, by the discovery of a process of soldering. All the labors expended on aluminium up to the month of March, 1859, are recounted by Deville, and as the author and founder of this manufacture, we can feel very certain that the work is not a simple compilation.

As respects the soldering of this metal, until very lately quite imperfect results have been attained. In the Universal Exhibition of 1855, there were pieces of aluminium soldered with zinc or with tin, but this weak solder did not give any solidity. Others have tried to solder with alloys of zinc, silver and aluminium. Mr. Denis of Nancy has noticed that whenever aluminium and the solder melted over its surface was touched with a slip of zinc, the adhesion took place with great rapidity as if a peculiar electric action gave it an impulse at the moment of contact; but this solder also has failed to afford much strength.

At last it has been suggested that the difficulty might be surmounted by previously coating the piece with copper, and then soldering together the coppered surfaces. In order to effect this, the aluminium, or at least the parts to be soldered, are plunged into a bath of acid sulphate of copper. The positive pole of the battery is put in direct communication with the bath, and the pieces to be coppered are touched with the negative pole; the deposit of copper takes place very regularly over the surface of the aluminium. These surfaces thus prepared are soldered in the ordinary way.

All these processes are, as is seen, very imperfect, and they now have only a historical interest, on account of a new and perfect method of

soldering just discovered. The inventor is a gilder and silverer of metals, belonging to Paris, named Mourey; he has recently announced his process in a public meeting of the Société d'Encouragement. The alloy employed is composed of zinc and aluminium; Mr. Mourey employs five different varieties of it according to the article to be soldered; the composition is as follows:

	I.	II.	III.	IV.	V.
Zinc,	80	85	88	92	94
Aluminium,	20	15	12	8	6

To prepare it, he melts the aluminium in a crucible of graphite, the metal having been reduced to fragments and added little by little; when the mass is in fusion it is stirred with an iron rod while the zinc is added in small quantities at a time; the alloy is still stirred while a little tallow is added to prevent the oxydation of the zinc, and then it is cast in small ingots. It is important to avoid too high a temperature lest the zinc should be volatilized. It is also important that the zinc should be free from iron.

These five alloys have different points of fusion. Alloy No. 1 is the hardest, the others are softer in regular succession.

As for the manipulation of the solder, this comes under technology: Mr. Mourey has described it in detail; but it would be going too much into specialities for us to cite his account of it, and we subjoin only a few facts interesting in a scientific point of view.

The instrument which is used in the soldering, and which is called in French "fer-a-souder," ought not in soldering aluminium to be either of iron or copper, but of aluminium itself; for the soldering alloy adheres to iron or copper in preference to aluminium. The flux used to facilitate the adhesion is made of three parts balsam of copaiba, mixed with one part of pure turpentine; the materials are mixed in a porcelain capsule, and a few drops of lemon-juice are added to favor the mixture of the two resins.

This flux is used for thoroughly impregnating the fragments of solder which are to be employed. It is important to use the blowpipe no longer than is necessary, to prevent loss of zinc from volatilization.

Lastly, another novelty of this branch of manufacture is aluminium bronze, which has the proportion of ten parts of aluminium to ninety of copper, and has the tenacity of steel. This alloy is now applied on a large scale by J. M. Christoffle; he has noticed that it is of great advantage to make all the surfaces of friction in machinery of aluminium-bronze. Thus a bearing which had been placed on a polishing lathe making 2200 revolutions a minute was found to last eighteen months, while bearings of other different metal, had, in the same circumstances, lasted at most only three months. He has employed this bronze with equal success in the manufacture of cannon, howitzers, and all kinds of weapons of war. Pistol-barrels have been thus made which have done good service.

There is as yet nothing very conclusive with regard to this application to artillery; but Mr. Christoffle, relying on the tenacity of aluminium-bronze and its resistance to wear, thinks that it will be applicable to the manufacture of bronze for cannons. As in France large artillery-pieces are constructed exclusively in the government work-shops, he has asked for a permit to manufacture at his own expense some pieces of artillery, especially such as are most exposed to injury.

ART. XVI.—*Seventh Supplement to Dana's Mineralogy*; by the Author.

List of Works, etc.

FR. VON KOBELL: Die Mineralogie. 248 pp. 12mo, with 4 plates. Leipzig, 1858. An excellent mineralogical manual.

Dr. T. SCHEERER: Löthrohrbuch.—A manual on the blowpipe and blowpipe analysis. 294 pp. 12mo. Braunschweig, 1857.

Dr. A. KENNGOTT: Uebersicht der Resultate mineralogischer Forschungen in den Jahren 1856 und 1857. 272 pp. 8vo. Leipzig, 1859.—Dr. Kenngott is now professor of mineralogy at Zurich, and still finds time to continue his excellent review of the progress of Mineralogy. This volume covers the years 1856 and 1857.

Dr. A. KENNGOTT: Tabellarischer Leitfaden der Mineralogie. 272 pp. 8vo. Zurich, 1859.

Dr. J. SCHABUS: Anfangsgründe der Mineralogie. 250 pp. 8vo. Vienna, 1859.

DELAFOSSE: Nouveau cours de minéralogie, comprenant la description de toutes les espèces minérales avec leurs applications directes aux arts. Tome 1er, 1re et 2e livraisons. Paris, 1858. 8vo, 550 pp., with an Atlas of 16 pages and 20 plates.

DUFRENOY'S Mineralogy.—The 4th volume of the new edition has just been issued at Paris.

Dr. RITTER VON ZEPHAROVICH: Mineralogischen Lexicon für das Kaiserthum Oesterreich.—Mineralogical Lexicon for the Austrian empire. This work is mentioned in the Bulletin of the K. K. geol. Reichs. for 1858, p. 116.

G. SUCKOW: Die Mineralogie in besonderer Beziehung auf chemisch-genetische und metamorphische Verhältnisse der Mineralien. 8vo. 1858.

Dr. J. G. KURR: Album de Minéralogie; in 4to with 22 colored plates. Paris. Firmin Didot frères. 30 fr.—Also translated into English and republished in London.

L. GRUNER: Description géologique et minéralogique du département de la Loire. xx and 779 pp. 8vo, with 7 charts. Paris, 1858.

ROSSI: Nuovi principii Mineralogici. 64 pp. 4to. Venice, 1857.—According to a notice in Jahrb. Min. 1858, 75, the work presents a new classification of minerals, dividing them into 6 classes and their subordinate groups. The classes are, 1. EXOGENS, the gases and water; 2. ENDOGENS, the sulphurets, tellurets, arseniurets, &c.; 3. HYPOGENS, the feldspars and related silicates; 4. PERIGENS, magnesia and aluminous hydrosilicates; 5. EPIGENS, carbonates, sulphates, chlorids, fluorids, &c.; 6. METAGENS, garnet, pyroxene, mica, tourmaline, spinel, &c.

J. H. SCHRÖDER: Elemente der rechnenden Krystallographie, with 73 figures and 5 lithographic plates. Clausthal, 1859.

J. W. BRÜCKE: 118 Stück Gypsabgüsse von naturlichen sowohl einfachen Krystallen.—Models of crystals including especially twins of the feldspars, by J. W. Brücke. Berlin, 1857. A pamphlet of 20 pages containing descriptions of the models.

H. D. ROGERS: The Geology of Pennsylvania, a Government Survey, with a general view of the Geology of the United States, Essays on the Coal Formation and its fossils and a Description of the Coal-fields of North America and Great Britain, by H. D. Rogers, State Geologist, Prof. Nat. Hist. Univ. of Glasgow, &c. 2 vols. 4to of 586 and 1046 pages, with numerous plates, maps, sections and woodcuts.—Prof. Rogers has given in his great work a number of analyses of mineral coal and iron ores, besides describing at length the mines of Pennsylvania.

J. Hall and J. D. Whitney: Report on the Geological Survey of the State of Iowa, embracing the results of investigations made during portions of the years 1855, 56, 57. 725 pp. large 8vo, with numerous plates.—Prof. Whitney has published analyses of various limestones, dolomites, iron ores, coals, and treated also briefly of the lead region of the Upper Mississippi.

W. E. Logan: Geological Survey of Canada, Report of Progress, for the year 1857. 240 pp. 8vo.—Contains information on the economical minerals of Canada, and a paper on Dolomites by T. S. Hunt.

O. M. Lieber: Report III. on the Geological Survey of South Carolina. 224 pp. 8vo with maps. 1858.—Contains chapters on the gold and other minerals and rocks of a part of South Carolina.

Hanns Bruno Geinitz: Das Königliche mineralogische Museum in Dresden. 110 pp. 12mo.—A catalogue of the minerals of the Dresden Museum and a plan of the building and arrangements.

C. U. Shepard: Report of the Mount Pisgah Copper Mine. 8 pp. 8vo. New Haven, 1859.—The copper ore is chalcopyrite. It occurs in gneissoid mica schist. The other minerals of Mt. Pisgah are vivianite in fine crystals, automolite, apatite, hyalite, staurotide, tremolite, chrysocolla, etc. An impure chlorite from the region is named *lepidochlore.* There is no analysis given, and no other good foundation for the new name.

In the same pamphlet, Prof. Shepard proposes names for mineral substances (of which he promises future descriptions) from Ducktown, a copper mine in the same vicinity, in eastern Tennessee. These names are *Copperasine* for a "hydrated ferrous cuprous and ferric sulphate;" *Leucanterite* for an efflorescence on the copperasine; *Erusibite* for a "rusty insoluble ferric sulphate;" *Stephensonite* for a "hydrosulphato-carbonate of copper, of a chrysoprase green color." Until they are fully described by the author, and complete analyses given, with other evidence that they are good species, these names can have no claims to recognition in the science. A common blackish copper ore from Ducktown is named *ducktownite*, making five so-called species from Ducktown. The mineral appears to the eye to be only a mixture. H.=5·5. G.=4·55—4·66 (Mr. R. A. Fisher). Color blackish steel-gray with a shade of bronze. Said to contain 30·76 iron, 26·04 copper, with 43·20 undetermined, but set down as "sulphur, by difference."

Prof. G. J. Brush has handed me the following notices of the Ducktownite and Lepidochlore.

"Having recently visited the Ducktown mines, I have obtained specimens of the so-called new species *ducktownite*, and after assuring myself of their authenticity by comparison with a specimen received from Prof. Shepard, I have submitted them to examination. A careful inspection with the magnifier shows that besides the quartz, malachite and limonite mentioned by Prof. Shepard, that the mass is made up of an intimate mixture of two substances, one of which has a bronze and the other a steel or blackish-gray color. Occasionally the mixture contains a small quantity of yellow copper pyrites. The bronze colored mineral selected as carefully as possible gave the following characters. Before the blowpipe in matrass yielded a copious sublimate of sulphur, indicating one of the higher sulphids. Pulverized and roasted in an open tube gave a reaction for sulphur and left a reddish residue. Fused on charcoal the assay became magnetic. A specimen carefully roasted on charcoal till sulphur ceased to be given off, was dissolved in salt of phosphorus; it gave a reaction for iron only, no reaction for copper was obtained even on fusing the bead with chlorid of sodium, thus proving the mineral to be entirely free from copper. Its hardness was sufficient to scratch feldspar; this together with the reactions in the matrass and on charcoal indicate that the substance under examination was *iron pyrites.*

The blackish-gray substance gave off no sulphur when examined in the matrass, but yielded sulphurous acid when treated in the open tube and on charcoal, and showed the presence of a large amount of copper. In hardness it was very inferior to the bronze mineral, but its mixture with the latter prevented an accurate determination. An assay made of a fragment of this mixture, containing a small amount (not over one or two per cent at most) of malachite and perhaps also a

small quantity of limonite, gave 46·70 per cent of metallic copper. The mixture with iron pyrites and the associating minerals was such that it was almost impossible to select the blackish-gray mineral pure.

These facts, however, are sufficient to prove that *ducktownite* is not a homogeneous substance. The low amount of copper obtained by Prof. Shepard is explained by his specimen having contained a very considerable admixture of iron pyrites. The substance I have examined is a mixture of iron-pyrites and a rich sulphid of copper, which if obtained pure would probably prove to be copper-glance. I am requested by Dr. R. A. Fisher to state that the specific gravities quoted by Prof. Shepard were taken upon fragments which contained malachite, quartz, and limonite, and are of no value further than as an approximative density of the ore.

In Professor Shepard's description of the substance he calls *lepidochlore*, he quotes me as authority for its specific gravity and chemical composition. The only examination I have made of it was to determine the density and the amount of water it contained, and in my report to Prof. Shepard I gave these with the remark, '*appears to be a mixture of chlorite and mica.*' Prof. Shepard gives no physical or chemical characters which distinguish the mineral from chlorite."

Ch. Herpin: Sur la Nomenclature et la Classification des eaux Minérales. 8vo. Paris, 1859.

J. Houël: Des principales eaux minerales de l'Europe. 8vo. Paris, 1858.

On the Microscopical Structure of Crystals, by H. C. Sorby, Quart. Journ. Geol. Soc., xiv, 453.—Treats mainly of the cavities in crystals, and draws from them some conclusions with regard to the origin of the rocks in which the crystals occur.

A list of pseudomorphic minerals occurring in Scotland, by Dr. Heddle (Phil. Mag., [4], xvii, 42.

On Pseudomorphism, or the Perimorphosis of Calcite and Epidote into Garnet, by A. Knop of Giessen, Jahrb. Min., 1858, 33.

On Heteromerism and Heteromerous minerals, by R. Hermann, J. f. pr. Chem., lxxiv, 256—314, lxxv, 385—448.

Alteration of Minerals.—Dr. H. Eichhorn has published (Pogg., cv, 126) an important paper on this subject. Pulverized *chabasite* was exposed to different weak solutions. (1) 4·0 grams of chabazite in water containing 4·0 grams of common salt to 400 cubic centimetres, for 10 days in the cold; (2) 15·0 grams, with 10·0 grams of chlorid of ammonium and 500 c. c. of water for 21 days; (3) 15·0 grams, with 20 grams crystallized carbonate of soda and 500 c. c. of water, for 21 days; (4) 15·0 grams with 10·0 grams of carbonate of ammonia in 500 c. c. water for 21 days. The following are analyses of true chabazite and the altered products:

			$\ddot{\mathrm{S}}\mathrm{i}$	$\bar{\mathrm{A}}\mathrm{l}$	$\dot{\mathrm{C}}\mathrm{a}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{N}}\mathrm{a}$	$\dot{\mathrm{H}}$
	Chabazite,		47·44	20·69	10·37	0·65	0·42	20·18 = 99·75
Altered	"	1,	48·31	21·04	6·65	0·64	5·40	18·33 = 100·37
"	"	2,	51·26	22·17	4·15	[0·61]		14·87 AmO 6·94 = 100
"	"	3,	48·39	20·76	5·64	6·86		18·46 = 100·11
"	"	4,	50·61	21·26	5·63	[0·87]		15·72 AmO 5·91 = 100.

Descriptions of Species.

Aciculite.—This ore from Beresowsk, has afforded R. Hermann (J. f. pr. Ch. lxxv, 450):

S 16·50 Bi 34·87 Pb 36·31 Cu 10·97 Ni 0·36 Au 0·09 = 99·00

corresponding to the formula $(\bar{\mathrm{C}}\mathrm{u}, \mathrm{Pb})\mathrm{S} + 3\mathrm{Bi}\,\mathrm{S}^{3}$.

ADELPHOLITE, *A. E. Nordenskiold* (Beskrif. Finland Min., &c., Jahrb. Min. 1858, 313).—A niobate or tantalate of iron and manganese with 9·7 per cent of water. Crystallization dimetric, the angles undetermined. H.=3·5—4·5. G.=3·8. Lustre greasy, subtranslucent. Brownish yellow to brown and black. Streak white or yellowish white. From Rajamaki in Tamela, Finland, with beryl and small crystals of tantalite.

Agalmatolite [p. 252, V].—Scheerer has referred the minerals from China included under Agalmatolite to three groups (Handwört. Chem.).

1. Common agalmatolite *or hydrous potash-alumina silicate.—First division* containing $1\dot{K}$, $3\ddot{\bar{A}}l$, $6\ddot{S}i$, $3\dot{H}$, [Min., p. 253, anal. 1, 2]. A *second* kind is mentioned under this group having the same constituents except $3\dot{R}$ in place of $1\dot{K}$. It is based on Thomson's analysis. [Min., anal. 3.]

2. *A hydrous alumina-silicate.*—He here includes Klaproth's analysis (Beit., ii, 189), $\ddot{S}i$ 62, $\ddot{\bar{A}}l$ 24, $\dot{C}a$ 1, $\dot{F}e\ddot{C}$ 0·05, $\dot{H}$ 10—97·50; also Lychnell and Walmstedt's [Min., p. 253].

3. *A hydrous magnesia-silicate*, or *steatite.*

Under the first group he places, besides Chinese specimens in a *first* division, the agalmatolite of Nagyag analyzed by Klaproth [Min., anal. 2]; a *second* that of Ochsenkopf, analyzed by John, and near Onkosin; a *third* the agalmatolite of Schemnitz, analyzed by Karafiat [Min., anal. 4], and the parophite and dysyntribite. These three divisions differ in having for the protoxyds, the first $1\dot{R}$, the second $2\dot{R}$, the third $3\dot{R}$.

[Scheerer, in his valuable paper, fails to note that *parophite* was described as a *rock* and not as a mineral by T. S. Hunt; and that *dysyntribite* was also proved to be a rock by Smith and Brush. The relation to agalmatolite is undoubted. But owing to the impurities present, it is not safe to infer the precise composition from the analyses. G. J. Brush in his article on the Gieseckite of Northern New York (this Jour., xxvi, 64, July, 1858, and VI Suppl., p. 350), shows that this gieseckite is in fact a potash-agalmatolite, and as it comes from the same region with the dysyntribite it is obvious that the latter is the same compound in an impure state. The constituents found by him were $6\dot{R}$, $7\ddot{\bar{R}}$, $12\ddot{S}i$, $9\dot{H}=(\dot{R}^3, \ddot{\bar{R}}, \dot{H}^3)\ddot{S}i$, which brings it most nearly to the third division. Prof. Brush also shows that the potash-pinites and liebenerite are related to the gieseckite and potash-agalmatolite. Besides, in his remarks on pyrophyllite (same vol. this Jour., p. 68), he proves that the "hydrous alumina silicate" agalmatolite, or that of the second group, is compact pyrophyllite, as suggested by Walmstedt.—D.]

ALISONITE, *Field* (this Jour., [2], xxvii, 387).—Alisonite is a sulphuret of lead and copper, from "Mina Grande," near Coquimbo, Chili. It has a deep indigo-blue color, quickly tarnishing on exposure; G.=6·10; H.=2·5—3. Associated with cerusite and malachite, and also vanadate of lead and copper. Composition:

S 17·00 Cu 53·63 Pb 28·25 = 98·88

corresponding to $3\mathrm{€uS}$, PbS, which requires Cu 53·33, Pb 28·88, S 17·77.

Analcime [p. 318, IV].—Rammelsberg has published some analyses of analcime in Pogg., cv, 317, sustaining the received formula. He mentions reasons for doubting the analysis of von Waltershausen [Min., No. 8].

Apatite [p. 396, I—VI].—An apatite from Krageroe, Norway, according to Völcker (Rep. Brit. Assoc., Dublin, 1857) contains no fluorine.

Aragonite [p. 448, II, III, IV, V].—The variety of aragonite containing lead, called *tarnowitzite*, has been examined crystallographically by Websky (Zeits. D. geol. Ges., ix, 737). The crystals were from Lazarowka, one to three lines long, and one-fifth to one line through. The faces observed are I, $i\text{-}\breve{i}$, $\frac{1}{2}\text{-}\breve{i}$, $1\text{-}\breve{i}$, 1, $\frac{1}{2}$, $2\text{-}\breve{2}$, $\frac{4}{3}\text{-}\breve{2}$, $\frac{2}{3}\text{-}\breve{2}$, $\frac{1}{3}\text{-}\breve{2}$, $\frac{4}{5}\text{-}\bar{2}$, $\frac{2}{5}\text{-}\bar{2}$, $\frac{4}{8}\text{-}\overset{\smile}{\frac{27}{25}}$, $\frac{27}{2}\text{-}\overset{\smile}{\frac{27}{25}}$. The angles by measurement, $I:I=116°\ 13'$, $I:1=143°\ 36'$. By calculation, $1\text{-}\breve{i}:1\text{-}\breve{i}=108°\ 34'$. Three very complex twins are finely figured on the plate.

A fine green aragonite occurs near Gerfalco in Tuscany, in radiated columnar forms. Marcel de Sevres attributes the color to the oxyds of copper and iron.—*L'Institut*, 1858, p. 351.

Asbolan or Earthy Cobalt [p. 126].—On the occurrence of Cobalt, and nickel ores in Gaston Co., North Carolina, H. Wurtz (Am. J. Sci., [2], xxvii, 24).

Autunite [p. 430, IV (p. 130), V, VII].—According to Descloizeaux, autunite is optically biaxial, and the prism, instead of square, is rhombic, with $I:I=90°\ 43'$.—*L'Institut*, 1859, 33.

BARNHARDITE [p. 500, I].—Under the name of *Homichlin*, Breithaupt has described an ore from Plauen in Voigtland (B. u. H. Zeit., xvii, 385, 424, and xviii, 65), identical with barnhardite in composition and other characters. Crystallization dimetric octahedral; mostly compact massive; G.=4·472—4·480; H.=4—5. Color a little more bronzy than chalcopyrite; streak black. *Composition* according to an imperfect analysis by T. Richter, Iron 22·1, copper 43·2, leaving 34.7 for sulphur and a small admixture of earthy substances. Richter writes the formula $2\text{€uS}+\text{FeS}^3$=Iron 22·3, copper 48·2, sulphur 30·5, which is precisely the composition given by Genth for the barnhardite. It is associated with kupferpecherz and malachite. Other localities are, Friedensgrube near Lichtenberg in Bavaria, Duchy of Hesse near Viedendorf, and at Breitenstein near Viedenkopf, Duchy of Nassau at Oberlahnstein, Kupferberg in Silesia, Johanngeorgenstadt, Lauterbach in the Hartz, Rheinbreitenbach on the Rhine, Quadmerget in Algeria, Chili at Remolinos and Tocopilla and Japan.

BARYTES [p. 366, II, V, VI].—The brachydome $\frac{5}{6}$-$\breve{i}$ has been observed by E. J. Chapman in a barytes crystal in the Museum of the University of Toronto (Canadian Jour. iv, 55).

BINNITE [II, III, IV].—This monometric mineral from Binnen valley contains, according to Stockar-Escher, (Kenngott's Min. Forsch. for 1856, '57, p. 174):

S	As	Cu	Ag
32·73	18·98	46·24	1·91

according to which the ratio for the As, S, Cu is 1 : 3 : 8, and he observes it is identical with *enargite* except in crystallization.

BLENDE [p. 45, II, V].—A brown blende from near Burbach in the Siegen district afforded C. Schnabel (Pogg., cv, 144) ZnS 70·45, FeS 12·59, insol. resid. 16·96 =5ZnS+FeS.

BOLTONITE [p. 167, I].—G. J. Brush has analyzed anew the boltonite of Shepard, and confirmed Dr. Smith's result that the mineral is *chrysolite*. He has also shown that the analysis of von Hauer, and the arguments of Kenngott based upon it, are wrong. He obtained (this Jour., xxvii, 395)—

$\dddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dddot{\text{Al}}$	ign.
42·82	54·44	1·47	0·85	*tr.*	0·76=100·34

It is therefore a very pure *magnesia-chrysolite*, a variety of the species not yet found elsewhere. H.=6—6·5. G.=3·21. Color ash-grey, but fragments almost colorless and nearly transparent. Cleavage very distinct in one direction. The crystals are imbedded in a limestone gangue, and the sections of them are often rectangular.

BORNITE.—See *Tetradymite*.

BREWSTOLINE [p. 471].—R. T. Simmlen has published a paper (Pogg., cv, 460), aiming to show that the expansible fluid observed by Brewster in topaz, quartz and amethyst, is *liquid carbonic acid.* The expansion of the Brewstoline in a change of temperature from 50° to 80° F. was 25 per cent; and according to Thilorier, liquid carbonic acid expands between 32° and 86° F. 45 per cent. In the former the rate per degree is 0·832, in the latter 0·833. The index of refraction of the Brewstoline, according to Brewster, is 1·1106 for a specimen in a Siberian amethyst, and 1·1311 for one in a Brazilian topaz, or less than the number for water (1·335); and although the exact number for carbonic acid has not been observed, it is stated by Davy and Faraday to be less than that of water.

BROCHANTITE [p. 391].—Brochantite, according to F. Sandberger (Pogg., cv, 614), occurs in Nassau, along with chalcopyrite, galena and chalybite, malachite and allophane. An analysis by H. Risse afforded $\dddot{\text{S}}$ 19·0, $\dot{\text{C}}\text{u}$ 67·8, $\dot{\text{H}}$ 13·2, and *trace* of chlorine, corresponding to the formula $\dot{\text{C}}\text{u}^7\dddot{\text{S}}^2+6\dot{\text{H}}$.

CALAMINE [p. 313, II].—Analysis of the white or colorless calamine from Santander in Spain, by C. Schnabel (Pogg., cv, 144):

$\dddot{\text{Si}}$	$\dot{\text{Zn}}$	$\dddot{\text{Al}}$, $\dddot{\text{Fe}}$	$\dddot{\text{P}}$	$\dot{\text{H}}$
23·74	66·25	1·08	*tr.*	8·34=99·41. G.=3·42.

CALCIFERRITE, *J. R. Blum* (Jahrb. Min., 1858, 287).—A mineral related to vivianite, of a sulphur-yellow, greenish yellow to siskin-green and yellowish white color, and sulphur-yellow streak; occurs crystalline foliated, with one very perfect cleavage affording thin lamellæ, and traces in two other directions, one at right angles to the perfect cleavage face and the other oblique. H.=2·5; G.=2·523—2·529, Reissig. Thin lamellæ translucent. B.B. affords a black shining magnetic globule. Easily decomposed by muriatic acid. Analysis by M. Reissig afforded—

	$\dddot{\ddot{P}}$	$\dddot{Al}$	$\dddot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$
	34·01	2·90	24·34	14·81	2·65	20·56=99·27
Oxygen,	19·16	1·35	7·27	4·23	1·06	18·27

affording therefore as the oxygen ratio for the protoxyds, sesquioxyds, phosphoric acid and water, nearly 6 : 9 : 20 : 20=$6\dot{R}$, $3\dddot{R}$, $4\dddot{\ddot{P}}$, $20\dot{H}$. Occurs in nodules in a deposit of clay at Battenberg in Rhenish Bavaria. The exterior of the nodules is massive and yellowish brown or reddish brown, and consists of the impure or altered calciferrite.

Calcite [p. 435, I—VI].—A grass green cleavable calcite from Central India contains according to S. Haughton (Phil. Mag., [4], xvii, 16), a siliceous skeleton, amounting to about 14 per cent of the whole, to which it owes its green color. The skeleton afforded on analysis—

$\dddot{Si}$	$\dddot{Al}$	$\dot{Fe}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$ and loss
54·59	4·74	22·84	0·94	4·90	11·99=100

giving the formula $(\dot{R}^3, \dddot{R})\dddot{Si}^3+3\dot{H}$. Mr. Haughton observes that the composition resembles that of *glauconite*. He names the rock, which is merely a mixture of calcite and the green mineral, Hislopite.

Analyses of many limestones by J. W. Mallet are given in Tuomey's Second Biennial Report on the Geology of Alabama; others by J. D. Whitney in Hall and Whitney's Report on Iowa.

Calderite.—See *Garnet*.

Cassiterite.—The tin ore of the veins at Evingtok near Arksut, Greenland, where the cryolite occurs, is associated with ores of lead, copper, zinc, iron and molybdenum, fluor spar, zircon, cryolite, etc. The veins vary from 10 inches to ¼ inch in width, and in the largest the tin ore occupies about 1 inch on one side of the vein.

Castelnaudite [p. 432].—See *Xenotime*.

Cimolite [p. 165].—A whitish material, a little greasy in lustre, having G.=2·319, found with orthoclase in granite from Nagpur, India, has been analyzed by S. Haughton (Phil. Mag., [4], xvii, 18) and found to contain:

$\dddot{Si}$	$\dddot{Al}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{H}$ (ign.)
65·93	20·97	0·30	0·45	11·61=99·26

The oxygen ratio for the alumina (including protoxyds) and silica is about 1 : 3·36. It is stated to be gritty under the agate pestle. Mr. Haughton proposes for the species the name *Hunterite*.

[The species appears to be cimolite, as the characters and composition are essentially the same. The grittiness under the agate pestle appears to indicate a slight admixture of free silica.—D.]

Cobalt, Black.—See *Asbolan*.

CONARITE, *Breithaupt*, B. u. H. Zeit., xviii, 1.—Supposed to be a hydrous phosphate of nickel. It occurs at Röttis in Voigtland with Breithaupt's Röttisite (which see). It is in small grains and crystals, with one perfect cleavage, and is probably monoclinic like vivianite, with the cleavage brachydiagonal. H.=2·5—3. G.=2·459—2·490. Color yellowish pistachio- and siskin-green, also olive-green; streak siskin-green. In thin lamellæ translucent. It is named from the Greek κοναρος, *evergreen*.

Copperasine.—See page 129.

CROCOISITE [p. 359].—Dauber has measured the angles of crocoisite with great care and published the results in Pogg. Ann., cvi, 150. He makes $I:I=86°\ 31'{\cdot}6$, $i2:i2=50°\ 24'$, $C=77°\ 22'\ 43''$, with a possible error of $1'\ 52''$, and the axial ratio for the orthodiagonal, clinodiagonal and vertical axis, is 1 : 0·96388 : 0·91751.

DEWEYLITE [p. 285].—Kenngott in his last supplement (p. 67, published in 1859) continues to place Deweylite under *Gymnite*, although the former name has the priority.

DIALLOGITE [p. 446, III].—Massive diallogite has been found at Placentia Bay, Newfoundland (T. S. Hunt in Logan's Canada Rep. for 1857), in slates supposed to be of Silurian age. Color fawn- to chestnut-brown. H.=4. G.=3·25. It contains, according to T. S. Hunt, 84·6 p. c. of carbonate of manganese, with 14·4 per cent of silica, with small portions of iron, lime and magnesia. All but two per cent of the silica were readily soluble in a dilute solution of potash.

DOLOMITES [p. 441, I, II, IV].—Analyses of many dolomites of Alabama by J. W. Mallet are given in Tuomey's Second Biennial Geol. Report of Alabama; also of dolomites of Canada, by T. S. Hunt, in Logan's Geol. Rep. Canada for 1857; and in Iowa by J. D. Whitney in Hall and Whitney's Iowa Report.

Dolomitic veins or spots in fossiliferous limestone.—According to the investigations of T. S. Hunt (Logan's Canada Rep. for 1857, p. 200), the grayish fossiliferous limestone of Dudswell is ordinary limestone consisting of carbonate of magnesia 1·3, sand 6·2, and the rest carbonate of lime. The fossils have a similar composition. But a yellowish material envelops the fossils or fills the veins, which is dolomitic, consisting of—

$\dot{Ca}\ddot{C}$	$\dot{Mg}\ddot{C}$	$\dot{Fe}\ddot{C}$	Insoluble, sand
56·60	11·76	3·23	26·72 = 98·31

There is here a mixture of dolomite and carbonate of lime; by means of acetic acid the latter was removed (with but 4·0 p. c. of carbonate of magnesia) and the residue (52 per cent) then gave

$\dot{Ca}\ddot{C}$	$\dot{Mg}\ddot{C}$	$\dot{Fe}\ddot{C}$
51·75	35·73	12·52 = 100

The *Portor* marble, a well-known black marble with yellowish veins, brought from the Gulf of Spezzia (and according to Savi of the Neocomian formation), also analyzed by Mr. Hunt, afforded the same results. The body of the rock contained only 1·0 per cent of carbonate of magnesia, while the veins afforded 35·5 per cent.

Ducktownite.—See page 129.

DUFRENOYSITE [p. 77, I, II. III, IV, V].—This prismatic mineral from Binnen valley, contains, according to Stockar-Escher, (Kenngott's Min. Forsch. for 1856, '57, p. 177):

S	As	Pb	Ag	Fe
23·97	22·01	53·30	0·24	—— = 99·52
24·22	25·27	49·22	0·94	0·25 = 99·90
25·30	26·33	46·83	1·62	—— = 100·08
25·77	26·82	47·39	*trace*	—— = 99·98

The mean result gives the formula $3PbS+2As^2S^3$. The last two analyses also approach the formula $4PbS+3As^2S^3$, which differs from that of plagionite or jamesonite, in the substitution of arsenic for antimony.

ELLAGITE, *A. E. Nordenskiöld* (Beskrifv. Finl. Min. etc., and Jahrb. Min., 1858, 313).—Probably monoclinic; two cleavages making 90° with one another. Lustre of cleavage surface pearly, shining; opake or feeble translucent. Color yellow, yellowish brown to yellowish red. Streak uncolored. B.B. yields water and with greater heat an enamel-white pearl. From Aoland in Finland. Formula deduced $\dot{Ca}^3\dddot{Si}^4+\bar{\dddot{Al}}\,\dddot{Si}+12\dot{\bar{H}}$.

ENARGITE.—*F. Field* has described (this Jour., xxvii, 52) under the name of *Guayacanite*, an arsenical sulphuret of copper which he has identified with enargite. It contains, according to Field, S 31·82, As 19·14, Cu 48·50=99·46, with traces of iron and silver. The formula deduced is $3\bar{Cu}S+AsS^5$. H.=3·5—4. G.=4·39.

Epidote [p. 306, II—VI].—Scheerer has published (J. f. pr. Chem., lxxv, 167) a paper opposing the analytical results of Hermann with regard to the presence of carbonic acid in epidote. In the epidote of Bourg d'Oisans and Arendal, Scheerer found neither carbonic acid nor protoxyd of iron. He states that the same error extends to Hermann's analyses of idocrase.

Erusibite.—See p. 129.

Franklinite [p. 166, I].—Franklinite in crystals occurs at the mine Victoria near Eibach in Nassau, according to C. Koch. The crystals are cubic. This species was first announced as existing in Nassau at the mine Breitehek by Jung in 1834.—Kenngott's Min. Forsch. for 1856, '57, p. 145.

Galena [p. 39, II, III, IV].—A galena affording before the blowpipe, like cuproplumbite, some copper and a trace of antimony, occurs at the mine of Antonio Cruz near Comayagua in Honduras, according to W. J. Taylor (Proc. Acad. N. Sci. Philad. Aug. 1858).

Garnet [p. 190, I—VI].—A mineral from Nepal named *Calderite* is, according to Söchting, massive garnet.—Kenngott's Min. Forsch. for 1856, '57, p. 115.

Analysis by R. Richter of a dark-red garnet from Mt. Agiolla in Traversella, Piedmont (Scheerer, in Kön. Sächs. Ges. der Wiss., 1858, p. 99):

$\ddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dddot{\text{Fe}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$
39·99	17·98	6·45	32·70	2·76=99·88

Oxygen ratio for R, R, $\ddot{\text{Si}}$=10·44 : 10·33 : 20·76.

Damour on the Subdivision of the Garnets into four groups.—L'Institut, xxiv, 441, and Jahrb. Min., 1858, 77.

Glauconite.—See under *Calcite*, and this Supplement.

Gersdorffite [p. 58].—Gersdorffite is found in fine crystals near Ems. Composition according to C. Bergemann (J. f. pr. Chem., lxxv, 244):

As	Sb	S	Ni	Co	Fe
45·02	0·61	19·04	34·18	0·27	1·02=100·14

It corresponds to the formula NiS^2+NiAs.

Gold [p. 7, I, II, V, VI].—Native gold occurs in Australia imbedded in apatite.

GONGYLITE *Thoreld*, A. E. Nordenskiöld (Beskrif. Finl. Min. etc., Jahrb. Min., 1858, 313).—An altered mineral occurring massive with cleavage in two directions. G.=2·7. H.=4—5. Lustre greasy, subtranslucent. Yellow or yellowish brown. Streak white. B.B. yields water and with a stronger heat fusing to a blebby glass. Formula, according to Thoreld, $(\dot{\text{Mg}}, \dot{\text{K}})^8\ \ddot{\text{Si}}^2+3\dddot{\text{Al}}\ \ddot{\text{Si}}^2+4\tfrac{1}{2}\dot{\text{H}}$, if a part of the iron is taken as protoxyd. From Yli Kitkajärvi in Finland.

Guayacanite.—See *Enargite*.

Gymnite.—See *Deweylite*.

Hematite [p. 113, II, III, IV].—Rammelsberg (Pogg., civ, 541) has found the martite (octahedral ore) of Brazil to contain 1·83 to 2·30 per cent of ptotoxyd of iron, and is inclined to regard it as a pseudomorph. Sp. gr. 5·155.

The octahedral iron of Vesuvius (ib., p. 542) contains according to Rammelsberg, while mostly $\dddot{\text{Fe}}$, either some protoxyd of iron or magnesia. Rammelsberg obtained (1.) $\dddot{\text{Fe}}$ 85·90, $\dot{\text{Mg}}$ 12·43, insoluble 1·22; (2.) $\dddot{\text{Fe}}$ 82·52, $\dot{\text{Mg}}$ 15·68, insol. 2·00; (3.) $\dddot{\text{Fe}}$ 92·91, $\dot{\text{Fe}}$ 6·17, $\dot{\text{Mg}}$ 0·82. The crystals are magnetic, and consist of hematite in laminæ through a magnesian magnetite. Specific gravity of 1 and 2, 4·654 and 4·659, which is less than in either hematite or magnetite; of 3, 5·235.

Herschelite [under Gmelinite, 321].—Descloizeaux has found that *herschelite* has a negative axis of refraction, and *hydrolite*, which is considered a variety of herschelite, a positive axis.—L'Institut, 1859, 33.

HOMICHLIN *Breithaupt.*—See *Barnhardite.*

Hornblende [p. 170, I, II, III, IV, VI].—Scheerer has reviewed at some length the paper on the composition of the Hornblende and Pyroxene group of minerals, in Pogg., cv, 598.

HYALOPHANE [I, III, V].—Stockar-Escher has analyzed hyalophane and found it to contain (Kenngott's Min. Forsch., 1856, '7, p. 107):

$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Ba}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{K}}$	$\dot{\mathrm{Na}}$	ign.
52·67	21·07	15 05	0·46	0·04	7·82	2·14	0·58=99·83

This makes it an oligoclase with part of the protoxyds replaced by baryta, giving the formula $(\dot{\mathrm{K}}, \dot{\mathrm{Ba}})\dddot{\mathrm{Si}}+\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}^2$. Specific gravity =2·801.—Kenngott's Min. Forsch. for 1856, '57, p. 107.

ILMENITE [p. 115, II, V].—The varieties of titanic iron have been investigated recently by Rammelsberg (Pogg., civ, 497). The following are the mean results of his analyses. The last column contains the ratio of $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$ to $\dddot{\overline{\mathrm{Fe}}}$ which he has deduced from the composition. 1, from Ingelsberg near Hof-Gastein, [same analyzed by von Kobell, Min. No. 1]; 2, Layton's Farm, near Warwick, Orange Co., New York; 3, Ilmen Mts., Ural [Min., Nos. 3, 4, 5, and Schmidt below]; 4, Egersund, Norway [Min., Nos. 7, 8, 9, 10]; 5, Krageröe, Norway; 6, *Iserine*, from Iserwiese; 7, *Washingtonite*, Litchfield, Ct. [Min., Nos. 13, 14]; 8, Eisenach; 9, Snarum, Norway; 10, Binnen Valley; 11, *Eisenrose*, St. Gothard [Min., No. 17]; 12, Krageröe. —The analyses A, B, C, are of anomalous titanic irons; A, Iserine, in grains which may be octahedral, or rhombohedral with the apex truncated; B, from the basalt of Unkel [Min., under Iserine]; C, titaniferous iron sand, magnetic, from the shores of Muggle Lake near Berlin.

	Sp. gr.	$\ddot{\mathrm{Ti}}$	$\dddot{\overline{\mathrm{Fe}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Mg}}$	Ratio. $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$: $\dddot{\overline{\mathrm{Fe}}}$
1.	4·689	53·03	2·66	38·30	4·30	1·65= 99·94	1 : 0
2.	4·313 & 4·293	57·71	——	26·82	0·90	13·71= 99·14	1 : 0
3.	4·81—4·873	45·93	14·30	36·52	2·72	0·59=100·06	6 : 1
4.	4·744 & 4·791	51·30	8·87[a]	39·83	*trace*	0·40=100·40	9 : 1
5.	4·701	46·92	11·48	39·82	——	1·22= 99·50	9 : 1
6A.	4·752	37·13	28·40	29·20	3·01	2·97=100·71	3 : 1
6B.	4·676	42·20	23·36	30·57	1·74	1·57= 99·44	3 : 1
7.	4·986	23·72	53·71	22·39	0·25	0·50=100 57	1 : 1
8.	5·060	16·20	69·91	12·60	0·77	0·55=100·03	1 : 2
9.	4·943	10·02	77·17	8·52	——	1·33 $\dddot{\overline{\mathrm{Al}}}$ 1·46=98·50	1 : 4
10.[b]	5·127 & 5·150	9·18	81 92	8 60	——	——= 99·70	1 : 4
11.	5·187 & 5·209	9·10	83·41	7·63	0·44	*tr.* =100 58	1 : 4
12.	5·2406	3·55	93·63	2·26	——	——=100·44	1 : 13
A.	4·400	57·19	15·67	26·00	——	1·74=100·60	
B.	4·905	8·27	51·81	37·22	2·03	0·78=100·11	
C.	5·075	5·20	61·36	30·25	1·23	0·48= 98·52	

[a] Trace of $\dot{\mathrm{Mn}}$. [b] Mean of two analyses.

The more important conclusions of Rammelsberg from his researches are as follows:—(1.) The common composition is $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$. (2.) Magnesia in the most of them replaces part of the protoxyd of iron; and in that from Layton's farm near Warwick, it amounts to 14 per cent, the composition corresponding to the formula $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}+\dot{\mathrm{Mg}}\ddot{\mathrm{Ti}}$. (3.) The preferable theory for the composition of the species is that of Mosander which makes it a titanate of protoxyd of iron, $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$ (the iron sometimes replaced by magnesium) with often more or less $\dddot{\overline{\mathrm{Fe}}}$, and usually in simple proportions; Rose's theory considers the varieties combinations of isomorphous sesquioxyds of titanium and iron, and this would require the existence of a sesquioxyd of magnesium. Rammelsberg also concludes that there is no true octahedral titanic iron, and that Iserine (analysis A) is a combination of $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$ and $\dddot{\overline{\mathrm{Fe}}}\ddot{\mathrm{Ti}}^3$ in the ratio of 4 : 1.

[The ratios between the $\dot{\mathrm{Fe}}\ddot{\mathrm{Ti}}$ and $\dddot{\overline{\mathrm{Fe}}}$ deduced by Rammelsberg are not in most cases the precise results of the analyses. Thus in No. 4, the ratio obtained for the protoxyds, titanic acid and sesquioxyd, 0·8 : 2·7 : 6 is made 1 : 3 : 6; and so in some other cases. Rejecting the idea of any titanate of iron being present, and taking simple the atomic ratio between the metals and the oxygen, according to Laurent's view of the constitution of such compounds, all the 12 analyses come quite closely under the formula of hematite, M^2O^3 (the species with which titanic iron is isomorphous), M standing for all the iron, titanium, manganese and magnesium that is

present. The following table shows that, excepting one or two cases, the coincidence is quite remarkable.

	Metals.	Oxygen.	Ratio.		Metals.	Oxygen.	Ratio.
Anal. 1.	21·77	32·11	1 : 1·48	Anal. 7.	20·52	30 80	1 : 1·50
" 2.	22·71	34·64	1 : 1·52	" 8.	20·29	30·62	1 : 1·51
" 3.	20 67	31·55	1 : 1·50	" 9.	20·14	30 29	1 : 1·50
" 4.	20·09	32·11	1 : 1·60	" 10.	20·07	30·14	1 : 1·50
" 5.	20·58	31·48	1 : 1·53	" 11.	20·23	30·44	1 : 1·50
" 6A.	21·17	31·67	1 : 1·50	" 12.	20·13	30·22	1 : 1·50
" 6B.	20·62	31·64	1 : 1·54				

In analysis A, the corresponding numbers are 20·62 : 33·96=1 : 1·65 ; in B, 21·11 : 27·87=1 : 1·32 ; in C, 21·47 : 27·65=1 : 1·29. The last two are nearly the ratios of magnetic iron (1 : 1·33), and, as Rammelsberg suggests, they appear to be titaniferous magnetite. As to A, which holds an excess of oxygen, Rammelsberg queries reasonably whether the collection of iserine grains might not have contained some free titanic acid (grains of the black variety of rutile), but concluded that it was improbable.—J. D. D.]

Crystals of ilmenite an inch and a half in diameter and half an inch thick have been found, according to W. J. Taylor (Proc. Ac. N. Sci. Philad., August, 1858), in a boulder on the Schuylkill near Fairmount, Pa.

IOLITE [p. 214].—A pseudomorph after iolite called *peplolite*, from Ramsberg in Sweden, has been examined by C. P. Carlsson (Kong. Vet. Akad. Förh. 1857, 241). H. = 3—3·5. G. = 2·68—2·75. The mean of three analyses, one by Mr. Sieurin, second by Aomark, and third by Carlsson, gives for the composition:

$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dot{\text{Fe}}$	$\dot{\text{Mn}}$	$\dot{\text{Ca}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
45·95	30·51	6·77	*tr.*	0·50	7·99	8·30 = 100·02

whence the oxygen ratio for $\dot{\text{H}}$, $\dot{\text{R}}$, $\dddot{\text{R}}$, $\dddot{\text{Si}}$, 1·52 : 1·00 : 2·95 : 4·93.

IRON (native) [p. 17, II].—Pieces of native iron are reported to have been found at Chotzen in Bohemia, imbedded in a limestone, the *Plänerkalk* (K. A. and J. G. Neumann, in the Jahrb. k. k. Geol. Reichs., 1857, 354). J. G. Neumann suggests that it is of meteoric origin, of the age of the Plänerkalk. An analysis afforded, Iron 98·33, graphite 0·74, arsenic 0·32, nickel 0·61. Its structure is not at all crystalline.

IWAARITE.—See *Schorlomite.*

KARELINITE, *R. Hermann* (J. f. pr. Chem., lxxv, 448).—Karelinite is an oxydsulphuret of bismuth, according to the analysis by Hermann, which afforded—

Oxygen 5·21 Sulphur 3·53 Bismuth 91·26

whence the atomic ratio for O, S, Bi, 3 : 1 : 4, corresponding to BiO^3+BiS. It is from the Sawodinsk mine in the Altai Mts., where it occurs with telluric silver. Lustre metallic. Fracture crystalline, cleavage perfect in one direction. Color lead-gray. H.=2. G.=6·60. It is mixed with gray earthy bismuthite ($3\dddot{\text{Bi}}\ddot{\text{C}}+\dddot{\text{Bi}}\dot{\text{H}}^4$). B.B. gives fumes of sulphurous acid, and a gray slag with a bead of bismuth. Named after Mr. Karelin who brought it from Siberia.

KAPNICITE [V].—This mineral, according to the examinations of Städeler, is probably wavellite, it containing $\dddot{\text{P}}$ 35·49, $\dddot{\text{Al}}$ 39·59, with 24·92 (loss) water.—Kenngott's Min. Forsch. for 1856, 1857, p. 33.

KEILHAUITE [341, I, III].—Analysis of the Keilhauite by Rammelsberg (Pogg. Ann., cvi, 296):

	$\dddot{\text{Si}}$	$\ddot{\text{Ti}}$	$\dddot{\text{Fe}}$	$\dddot{\text{Al}}$	$\dot{\text{Ca}}$	$\dot{\text{Y}}$	$\dot{\text{Mn}}$	$\dot{\text{Mg}}$	$\dot{\text{K}}$	ign.
1.	29·48	26·67	6·75	5·45	20·29	8·16	*trace*	0·94	0·60	0·54
2.	28·50	27·04	5·90	6·24	17·15	12·08	*trace*	*trace*	—	3 59

The second was made on a crystal, but it was a little altered and softened at the surface. Rammelsberg obtains for the oxygen of $\dot{\text{R}}$, $\dddot{\text{R}}$, $\ddot{\text{Ti}}$, $\dddot{\text{Si}}$, the ratio 7·79 : 4·56 : 10·59 : 15·31 in No. 1, and 7·30 : 4·68 : 10·73 : 14·80 in No. 2. He unites the oxygen

of the silica and titanic acid, and derives thence for $\dot{R}+\dddot{\bar{R}}$, $\ddot{Ti}+\dddot{Si}$, the ratios 1 : 2·09, 1 : 2·13, and writes the formula 5($\dot{Ca}$, $\dot{Y}$)$\dddot{Si}$+($\dddot{\bar{Al}}$, $\dddot{\bar{Fe}}$)$\ddot{Ti}^3$.

[The mean of the two analyses affords in fact very nearly 7·5$\dot{R}$: 1·5$\dddot{\bar{R}}$: 5¼$\ddot{Ti}$: 5$\dddot{Si}$ (=7·5 $\ddot{Si}$), or 5$\dot{R}$: 1$\dddot{\bar{R}}$: 3·5$\ddot{Ti}$: 5$\dddot{Si}$, which gives one-sixth too much titanic acid for the above formula. Under ilmenite (page 136) it is shown that the composition of that species is best expressed by a formula in which the titanium is not in the state of titanic acid, but in that of a metal replacing the other metals, in accordance with Laurent's theory. The fact confirms the view taken of sphene in the Mineralogy, in which Rose's formula, 2$\dot{Ca}\dddot{Si}$+$\dot{Ca}\ddot{Ti}^3$ (=3$\dot{Ca}$+3$\ddot{Ti}$+2$\dddot{Si}$) is made equivalent to $\dddot{\bar{R}}^3\,\dddot{Si}^2$, (since $\dot{Ca}+\ddot{Ti}=RO+RO^2=R^2O^3$, and $3\dot{Ca}+3\ddot{Ti}=3R^2O^3=3\dddot{\bar{R}}$). The oxygen ratio between the silica and other ingredients in sphene is 2 : 3. Now in the above analyses by Rammelsberg, there is the same oxygen ratio between the silica and the other ingredients, it being in No. 1, 15·31 to 22·94=2·002 : 3·000, and in No. 2, 14·80 : 22·71=1·96 : 3; 2 : 3 is therefore the *fundamental* ratio of the species (and this is so, of course, whether silica be $\dddot{Si}$ or $\ddot{Si}$). Hence comes the formula ($\dot{R}^3$, $\dddot{\bar{R}}$)$^3\,\dddot{Si}^2$, which is equivalent to ($\dot{R}^3$, $\dddot{\bar{R}}$) $\dddot{Si}^{\frac{2}{3}}$, as given in the Mineralogy, p. 341, from Erdmann's analysis, and since confirmed by Forbes. Erdmann's analyses, as calculated by Rammelsberg, afford the same result, giving for the ratio 15·58 : 23·79 =1·97 : 3; and 15·30 : 23·44=1·96 : 3.—J. D. D.]

KRANTZITE, *C. Bergemann* (J. f. p. Chem., lxxvi 65).—Krantzite is a fossil resin from the brown coal of Lattorf, and had been considered impure amber. It occurs in grains and roundish pieces, showing by its structure that it was once fluid. Color yellowish, but mostly brown to black from earthy impurities. It is so soft as to be easily cut, and is elastic; no peculiar smell; G.=0·968; or of the crust portion 1·002. Fuses at 225° C. without change of color, and is perfectly fluid at 288°; at 300° there distils over a brownish oil of very disagreeable and penetrating odor.

LABRADORITE [237, II].—A. E. Nordenskiöld has given the name *Ersbyite* to the anhydrous scolecite of Nordenskiöld the father [Min., p. 237]. It is monoclinic, or perhaps triclinic, and has the formula $\dot{Ca}\dddot{Si}$+$\dddot{\bar{Al}}\dddot{Si}$, the formula of labradorite. From Ersby.—Beskrifv. Finl. Min. etc., in Jahrb. Min., 1858, 313.

LAPIS LAZULI [229, VI].—Two Siberian localities of lapis lazuli are described by N. Wersseloff in the Bull. de la Soc. Imp. des Naturalistes de Moscou, 1857, No. 4, p. 518. The mineral occurs in limestone intersecting syenite. As remarked by Nordenskiöld, the colorless and greenish lapis lazuli becomes blue on heating.

LAZULITE [404, II].—Lazulite occurs in beautiful sky-blue crystals in Lincoln Co., Georgia, on Graves' Mountain, about twelve miles northwest of the auriferous belt known as the Columbian gold mines, 50 miles above Augusta, as described by C. U. Shepard (this Jour., [2], xxvii, 36). In the same region occur kyanite, rutile, pyrophyllite, hematite. The lazulite occurs in certain layers of a bed of itacolumite disseminated through them in crystals from one-quarter to one inch long. The paper contains figures of the forms.

LEADHILLITE [371].—According to C. U. Shepard (this Jour., xxvii. 40) occurs in small quantities at the Morgan Silver Mine, in Spartanburg District, S. C., with pyromorphite and cerusite.

LEPIDOMELANE [227].—The black mica, &c., see Geol. Soc. Proc. in Phil. Mag., xvi, p. 396.

LIMONITE [131, II, IV].—Analyses of various limonites of Alabama are given in Tuomey's Second Biennial Geol. Rep. of Alabama.

LIROCONITE [429].—The crystallization of liroconite, according to Descloizeaux (L'Institut, 1859, 33) is monoclinic, having I : I=74° 21′, and the vertical axis inclined 25° from a vertical.

MAGNETITE [105, II, IV, VI].—Rammelsberg in Pogg., civ, 536, gives several analyses. In some there is a little magnesia. One from basalt near Eisenach,

afforded 0·10 titanic acid and 1·20 magnesia, with $\dddot{\text{Fe}}$ 69·88, $\dot{\text{Fe}}$ 27·88=99·06. See further under ilmenite and hematite.

Mellite [475, II].—A new locality has been found in Russia, in the district of Nertschinsk, at the mine of Dmitrirwsk, in bituminous coal.

Microcline [242, VI].—Breithaupt has described (Berg. u. Hütt. Zeit., xvii, 324) a twin consisting of albite and microcline, in which the two have the vertical axis parallel and the faces of perfect cleavage (P) precisely coincident, showing an identity in the inclinations of the planes. Breithaupt cites an analysis from Pogg., lii, 467, by Awdajeff, agreeing with microcline in the composition, affording, viz., $\dddot{\text{Si}}$ 67·20, $\dddot{\text{Al}}$ 20·03, $\dddot{\text{Fe}}$ 0·18, $\dot{\text{K}}$ 8·85, $\dot{\text{Ca}}$ 0·21, $\dot{\text{Mg}}$ 0·31, $\dot{\text{Na}}$ 5·06, the formula of which may be written $[\dot{\text{K}}\dddot{\text{Si}}+\dddot{\text{Al}}\dddot{\text{Si}}^3]+[\dot{\text{Na}}\dddot{\text{Si}}+\dddot{\text{Al}}\dddot{\text{Si}}^3]$.

Molybdenite [66, I, IV].—Observations on the crystallization of molybdenite are published by A. Knop, in Jahrb. Min., 1858, 43.

Natrolite [327, VI].—R. Blum has a paper on the pseudomorphs of natrolite after oligoclase and nepheline, from the zircon-syenite of Norway, in Pogg., cv, 133, showing that the natrolite is not an original mineral of the rock, as Scheerer argued, but a result of alteration.

Neotokite [169].—This mineral, according to A. E. Nordenskiöld (Beskrif. Finl. Min., Jahrb. Min., 1858, 313, and Kopp's Jahresb. for 1857), has the formula $\dot{\text{Mg}}\dddot{\text{Si}}+4(\dddot{\text{Fe}}, \dddot{\text{Mn}})\dddot{\text{Si}}+8\dot{\text{H}}$. It is amorphous. G.=2·7—2·8. H.=3·5—4·0. Color black to brownish-black. Streak brown. Opaque or feeble subtranslucent. B.B. yields water, but is infusible. From Gaosböle in Finland.

NICKEL ORES.—C. Bergemann has described (J. f. pr. Chem., lxxv, 239) two new arsenates of nickel, differing from the common arsenate in containing no water and also pure oxyd of nickel. They occur at Johann-georgenstadt.

(1.) Crystalline, sometimes amorphous. Dark grass green. H.=4. G.=4·838. No fumes on heating in a glass tube. B.B. on charcoal, arsenical fumes.

(2.) Amorphous. Sulphur-yellow. H.=4. G.=4·982. With heat like the preceding. Composition:

	$\overset{...}{\text{As}}$	$\overset{...}{\text{P}}$	$\dot{\text{Ni}}$	$\dot{\text{Co}}$	$\dot{\text{Cu}}$	$\dddot{\text{Bi}}$	$\dddot{\text{Fe}}$
(1.)	36·57	0·14	62·07	0·54	0·34	0·24	*tr.* = 99·90
(2.)	50·53	*tr.*	48·24	0·21	0·57	0·62	— =100·17

Formula of (1.) $\dot{\text{Ni}}^5\overset{...}{\text{As}}$=arsenic acid 38·01, oxyd of nickel 61·99.

Formula of (2.) $\dot{\text{Ni}}^3\overset{...}{\text{As}}$=arsenic acid 50·54, oxyd of nickel 49·46.

(3.) The *oxyd of nickel* occurs in regular octahedral crystals with faces of the rhombohedron, one-half a line long. Color dull pistachio-green. H.=5—6. G.= 6·398. Composition, pure protoxyd of nickel. The crystals are not perceptibly attacked by acids or by fusion with alkaline carbonates.

Nickel-Gymnite [286].—Reported by W. J. Taylor (Proc. Ac. N. Sci. Philad., Aug. 1858) from Webster, Jackson Co., N. C., where it occurs as an amorphous reniform incrustation in serpentine along with chromic iron. Color apple-green to a yellowish-green. H.=3.

Breithaupt has described under the name of *Röttisite* (B. u. H. Zeit., xviii, 1) an impure hydrous silicate of nickel from Röttis in Voigtland. It occurs in amorphous masses and incrustations or seams, of a nearly pure emerald-green to apple-green color, apple-green streak, little lustre, translucent to subtranslucent, and opaque when earthy; H.=2—2·5; G.=2·358—2·370. An analysis by C. Winkler is given as follows:

$\dddot{\text{Si}}$	$\dddot{\text{Al}}$	$\dddot{\text{Fe}}$	$\dot{\text{Ni}}$	$\dot{\text{Co}}$	$\dot{\text{Cu}}$	$\dot{\text{H}}$	$\overset{...}{\text{P}}$	$\overset{...}{\text{As}}$
39·15	4·63	0·81	35·87	0·67	0·40	11·17	2·70	0·80

The sum is stated to be 100·79, but the numbers as they stand add up only 96·25 (or 4·54 less). The analyst observes that the sum of the silica, oxyd of nickel and water is 91·42 (it is as printed 4·63 less or 86·79), and thence deduces the formula $3\dot{\text{Ni}}\dddot{\text{Si}}+4\dot{\text{H}}$=Silica 48·31, $\dot{\text{Ni}}$ 39·15, $\dot{\text{H}}$ 12·54. It hence appears that there is a ty-

pographical error in the statement of the silica of between 4 and 5 per cent. [The mineral is said to occur with a *phosphate* of nickel (see *Conerite*); but the chemist, instead of allowing part of the oxyd of nickel to be combined with the 3·50 of phosphoric and arsenic acids (which might take up 2 per cent), and part of the silica with the alumina, selects out the silica, oxyd of nickel and water, and uses these alone to make out a formula. There is no sufficient evidence that the mineral is not identical with the *nickel-gymnite* of Genth (see Min., p. 286).—D.]

ORTHOCLASE [242, II, III, V, VI].—The feldspar of the zircon-syenite has been analyzed by Dr. C. Bergemann (Pogg., cv, 118) and the view confirmed of its being a soda-bearing orthoclase.

OSTEOLITE [398].—The osteolite of the Kratz mountain near Friedland in Bohemia, a snow-white earthy mineral having G.=2·828 to 2·829, afforded Dürre (Pogg., cv, 155):

$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	$\dot{Ca}$	$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dot{Mg}$	Cl	$\dot{H}$
34·64	44·76	8·89	6·14	0·51	0·79	*tr.*	2·97=98·70

The phosphate is mixed with a silicate; the former contains of the above, $\overset{\cdot\cdot\cdot\cdot\cdot}{P}$ 34·64 and $\dot{Ca}$ 40·985. The silicate has the composition nearly of an epidote, the formula being $\dot{Ca}^3\dddot{Si}+2\dddot{\bar{Al}}\dddot{Si}$.

PECTOLITE [305, II, III, VI].—Analyses 5, 6, in the author's Mineralogy are of the pectolite of Bergen Hill, New Jersey.

PELICANITE.—This mineral occurs as the base of a granitic rock in Russia, in the government Kiew, and is announced and described by Ouchakoff. (Bull. de St. Petersbourg, No. 369, p. 129, Jour. f. Prakt. Chem. lxxvi, 255, and Kopp's Jahresb. for 1857, 673). It is related to cimolite, a product of decomposition. The color is pale greenish; fracture conchoidal; at the edges translucent. G. = 2·256. B.B. burns white and does not melt even on the edges. Composition:

$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dddot{\bar{Fe}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{K}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	$\dot{H}$	Quartz
58·90	20·49	0·39	*tr.*	0·50	0·29	0·16	8·35	10·30=99·38

affording the formula $\dddot{\bar{Al}}\dddot{Si}^3+2\dot{H}$.

PEROFSKITE [345, II, IV, VI].—Descloizeaux has found (L'Institut, 1859, 33) that perofskite has two axes of double refraction quite distant, with the bisectrix negative. This was observed on specimens of a brownish yellow color from Zermatt and the Urals; and it is a question whether the black crystals from the Urals, which appear to be monometric, are not pseudomorphs.

PHOSPHORCHALCITE [425, II, VI].—The *Ehlite* from Ehl, has been analyzed by Dr. C. Bergemann and found to contain vanadic acid. His analysis afforded (Jahrb. Min., 1858, 195):

	$\overset{\cdot\cdot\cdot\cdot\cdot}{P}$	$\overset{\cdot\cdot\cdot\cdot\cdot}{V}$	$\dot{Cu}$	$\dot{H}$
	17·89	7·34	64·09	8·90
Oxygen,	10·12	1·90	12·98	7·90

PYROPHYLLITE [303, I, V, VI].—A mineral resembling massive pyrophyllite, according to W. J. Taylor (Proc. Ac. N. Sci. Philad., Aug. 1858), but not yet analyzed, containing imbedded quartz crystals, at a coal mine in Schuylkill Co., Pa. It is a tough, whitish mineral with a pearly lustre, somewhat greasy feel, forming a layer not over one-eighth inch thick.

Locality of pyrophyllite in Georgia, see under *Lazulite*.

PYROXENE [158, I, II, V, VI].—The pale green *smaragdite* of the euphotide of the Alps afforded T. S. Hunt (this Jour., [2], xxvii, 348):

$\dddot{Si}$	$\dddot{\bar{Al}}$	$\dot{Ca}$	$\dot{Mg}$	$\dot{Fe}$	$\dddot{\bar{Cr}}$	$\dot{Ni}$	$\dot{Na}$	ign.
54·30	4·54	13·72	19·01	3·87	0·61	*tr.*	2·80	0·30—99·15
		14·22	18·07	2·34				

whence the oxygen ratio for $\dot{R}$, $\dddot{\bar{R}}$, $\dddot{Si}$, 13·29 : 2·12 : 28·96.

The *traversellite* of Scheerer is a leek-green mineral, having the crystalline form of pyroxene, from Traversella in Piedmont in a mine of magnetic iron. It is softer

than this mineral but looks like a slightly altered variety. Composition according to R. Richter (Pogg. Ann., xciii, 109):

$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$	$\dot{\mathrm{H}}$
52·39	1·21	20·46	7·93	14·41	3·69=100·09

The oxygen ratio for the $\dot{\mathrm{H}}$, $\dot{\mathrm{R}}$, $\dddot{\overline{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$, is 3·28 : 12·58 : 0·56 : 27·20. The crystals are rectangular prisms, having the faces *i-i*, *i-ì* large, and *I* small, with the basal plane *O*. (Ber. Kön. Sächs. Ges. der Wiss., June 1858, p. 92.) Scheerer regards the mineral as an example of what he calls *paramorphosis*.

Pyrgom, according to Scheerer (Ber. Kön. Sächs. Ges. der Wiss., June 1858, p. 96) is augitic in crystallization. Richter obtained:

$\dddot{\mathrm{Si}}$	$\dddot{\overline{\mathrm{Al}}}$	$\dot{\mathrm{Fe}}$	$\dot{\mathrm{Mn}}$	$\dot{\mathrm{Ca}}$	$\dot{\mathrm{Mg}}$
31·79	4·03	7·57	*trace*	18·98	17·40=99·77

giving the oxygen ratio for $\dot{\mathrm{R}}$, $\dddot{\overline{\mathrm{R}}}$, $\dddot{\mathrm{Si}}$, 14·06 : 1·88 : 26·89. The form is a rhombic prism *I*, with the pyramidal planes +1, −1, +2, −2, and occasionally some others.

Quartz [145, II, III, IV].—A peculiar form of quartz, from different localities, and mostly the rock called melaphyre, has been named by Dr. Jenzsch (Pogg., cv, 320) *Vestan*, under the idea that it is a distinct species, quartz being therefore considered dimorphous. The form given is monoclinic and imperfect unequal cleavage is stated to occur in three directions. The angles are stated to be only approximative. Two of them, 95½° and 133°, are very near angles in quartz ($R:R$ and $R:-R$).

RETZBANYITE, *R. Hermann* (J. f. pr. Chem., lxxv, 450).—This is a bismuth ore resembling telluric silver, and from Retzbanya. Color lead-gray, but externally oxydized and mixed with cerusite and bismuth ochre. In irregular pieces with no trace of crystalline structure. H.=2·5. G.=6·21. B.B. fumes of sulphurous acid; with soda is reduced to a globule of lead and bismuth. Afforded on analysis by R. Hermann:

O	S	Bi	Pb	Ag	Cu
7·14	11·93	38·38	36·01	1·93	4·22=99·61

giving the atomic ratio for the oxygen, sulphur, bismuth, and other metals, 8 : 7 : 3 : 4, and making, according to Hermann, a compound of a sulphate and oxysulphuret, with the formula [2CuS, PbS+3BiS]+2$\dot{\mathrm{P}}\mathrm{b}\dddot{\mathrm{S}}$.

Röttisite, *Breithaupt*.—See *Nickel-Gymnite*.

Rutile [120, V].—In the vicinity of the lazulite locality, Lincoln Co., Georgia (see lazulite), occur, according to C. U. Shepard (this Jour., xxvii, 36), splendent gigantic crystals of rutile, some weighing upwards of a pound. One has six geniculations.

Saponite.—A hydrous aluminous silicate from the waters at Plombières has been analyzed by J. Nicklès and designated *Saponite*, a name that has for some time belonged to a magnesian silicate. The mineral was found to consist of Silica 42·30, alumina 19·20, water 38·54, equivalent to $\dddot{\overline{\mathrm{Al}}}\dddot{\mathrm{Si}}^{3}+12\dot{\mathrm{H}}$, or near cimolite.—L'Institut, No. 1318, April 6, 1859.

Saussurite [234, II, IV, VI].—The doubts about saussurite have been well cleared up by T. S. Hunt (this Jour., [2], xxvii, 336). He shows that three species have been confounded under the name—similar in a white or a pale greenish white color, and a tough compact texture—viz. (1.) Labradorite or a related feldspar; (2.) Epidote; (3.) Garnet. The original saussurite of the euphotide of the Alps is a lime-alumina epidote, having G.=3·25—3·36.

Schorlomite [342, IV].—A. E. Nordenskiöld has described (Beskrif. Finland Min., &c., from Jahrb. Min., 1858, 312) a mineral having apparently the characters of schorlomite under the name of *Iwaarite*. Like schorlomite it is found in Elæolite, is lustrous iron-black resembling black or crystallized melanite, with the streak gray, and contains much titanium. It is either in monometric crystals or massive. The analysis is not cited in the Jahrbuch. The formula given is $\dot{\mathrm{C}}\mathrm{a}^{3}\dddot{\mathrm{Si}}+\dddot{\overline{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{Si}}+\frac{1}{2}\mathrm{TiO}$, $\mathrm{Ti}^{2}\mathrm{O}^{3}$, while that written for schorlomite by Whitney is $\dot{\mathrm{C}}\mathrm{a}^{3}\dddot{\mathrm{Si}}+\dddot{\overline{\mathrm{F}}}\mathrm{e}\dddot{\mathrm{Si}}+\dot{\mathrm{C}}\mathrm{a}\mathrm{Ti}^{2}$.

B.B. fuses to a black glass. Comes from Iwaara in the Kunsamo Kirchspiel in Finland.

Scorodite [419, I].—Lippmann has named a mineral found in small bluish crystals at Schneeberg, *Cobalt-scorodite.* It occurs with hypochlorite and quartz.—Kenngott's Min. Forsch. for 1856, 1857, p. 34.

Serpentine (282, I—VI].—Antigorite, shown to be slaty serpentine by G. J. Brush, has since been analyzed by Stockar-Escher with the same result (Kenngott's Min. Forsch., 1856, '7, 72). The mean of two analyses is—

$\ddot{\text{Si}}$	$\dddot{\bar{\text{Al}}}$	$\dot{\text{Fe}}$	$\dot{\text{Mg}}$	$\dot{\text{H}}$
40·83	3 20	5·84	36·26	12·37=98·86.

Stockar-Escher regards the alumina as replacing the silica.

Kenngott has described under the name of *Vorhauserite*, a mineral from the Fleims Valley in the Tyrol at Monzoni, having the composition of *Retinalite*, but impure with a little oxyd of manganese and iron. It occurs amorphous, of a brown to greenish-black color; weak waxy lustre; yellowish, pale or brownish yellow to brownish streak; H.=3·5; G.=2·45. Analysis by J. Oellacher (Kenn. Min. Forsch., 1856–57, p. 71):

$\ddot{\text{Si}}$	$\dot{\text{Mg}}$	$\dot{\text{Fe}}$	$\dddot{\bar{\text{Mn}}}$	$\dot{\text{H}}$	
41·21	39·24	1·72	0·30	16·16,	CaCl, $\dot{\text{Ca}}^3\ddot{\bar{\text{P}}}$ 0·9=99·59

Retinalite is probably *serpentine* mixed with a little Deweylite.

A pseudomorph after chromic iron occurs in Unst, according to Dr. Heddle (Phil. Mag., [4], xvii, 42).

Smithsonite [447, I, III].—Smithsonite from near Wiesloch contains carbonate of cadmium. It has a citron-yellow to wax-yellow color. An analysis in the laboratory of Prof. Bunsen afforded:

$\dot{\text{Zn}}\ddot{\text{C}}$	$\dot{\text{Cd}}\ddot{\text{C}}$	$\dot{\text{Ca}}\ddot{\text{C}}$	$\dot{\text{Fe}}\ddot{\text{C}}$	$\dot{\text{Mg}}\ddot{\text{C}}$	$\dot{\text{Zn}}, \dot{\text{H}}$	ZnS	Sand
89·97	3·36	2·43	0·57	0·32	1·94	0·47	0·45=99·51

Specular Iron.—See *Hematite.*

Sphene [268, III].—A Vesuvian mineral hitherto referred to the species sphene (the semeline of Fl. de Bellevue) has been described by G. Guiscardi under the name of *Guarinite*, after Prof. G. Guarini of Naples. (Zeit. D. geol. Gess. x, 14.) It is stated to occur in *dimetric* crystals, with difficult cleavage. Color honey-yellow. Translucent or transparent. Lustre subadamantine and adamantine on cleavage faces. H.=6—6·5. G.=3·487. Composition:

$\ddot{\text{Si}}$	TiO^2	$\dot{\text{Ca}}$	Fe, $\dddot{\bar{\text{Mn}}}$
33·64	33·92	28·01	*trace* = 95·57

The author observes that the composition is near that of the sphene of Piedmont (Greenovite, *Dufr.*).

Stiblite [142].—An antimony ochre occurs with antimonial nickel-glance and spathic iron near Eisern in the Siegen District, and contains, according to C. Schnabel (Pogg., cv, 146) $\dot{\text{Ni}}$ 0·17, $\dddot{\bar{\text{Fe}}}$ 5·56, $\dot{\text{H}}$ 9·42, along with antimonious acid 84·85. The oxyd of iron is hydrated.

SUNDVIKITE, *A. E. Nordenskiöld* (Beskrif. Finl. Min., and Jahrb. Min., 1858, 313).—An altered anorthite.

Tetradymite [21, 512, I].—C. U. Shepard has described (this Jour., [2], xxvii, 39) tetradymite from Lumpkin Co., Ga. It occurs in gneiss. It is associated with gold, pyrrhotine, chlorite, ilmenite in broad curved crystals, and some allanite and apatite. He observes that it is also found at the Pascoe Mine in Cherokee Co., and at a place near Van Wort in Polk Co.

Dr. C. T. Jackson has analyzed the tetradymite of Dahlonega, Georgia, and ascertained that it is the mineral, usually arranged under tetradymite, called bornite. He obtained (this Jour., [2], xxvii, 366):

Te	Se	Bi	Gold (mixed)
18·00	1·18	79·08	0·60=98·86

agreeing nearly with the analyses of the Brazilian bornite by Damour. Sp. gravity $=7{\cdot}868$.

THERMOPHYLLITE [Suppl. VI].—The thermophyllite of Hoponsuo contains, according to A. B. Northcote (mean of two analyses) Phil. Mag., [4], xvi, 263:

$\dddot{Si}$	$\ddot{Al}$	$\dot{Fe}$	$\dot{Mg}$	$\dot{Na}$	$\dot{H}$	$\dot{H}$ expelled at 212° F.
41·48	5·49	1·59	37·42	2·84	10·58	0·30 = 99·70

It is stated to occur in aggregated masses of a brownish gray color and semi-translucent, in some parts micaceous, through a rock of massive thermophyllite; crystalline form not determinable. [It resembles vermiculite in appearance and action before the blowpipe.]

TITANIC IRON.—See *Ilmenite.*

TOURMALINE [270, II, IV].—A fine large pinite-like pseudomorph after tourmaline, three inches long and two in diameter, is described by Mr. Tamnau (Zeits. D. geol. Ges., x, 12). It contains some unaltered black tourmaline. The crystal is a 6-sided prism with the faces also of a 12-sided prism. It was from Rosenbach in Silesia.

VAUQUELINITE [360].—Occurs, according to W. J. Taylor (Proc. Ac. N. Sci. Philad. Aug. 1858), at the Pequa Lead Mine, Lancaster Co., Pennsylvania, in minute crystals with acute terminations, often in radiated aggregations incrusting quartz and galena. The color varies from siskin to apple-green. Small crystals of *cerusite* occur in the cavities of the galena.

VORHAUSERITE, *Kenngott.*—See *Retinalite* under Serpentine.

WAVELLITE [423, IV].—A compound approaching wavellite in composition, occurs, according to A. Gages (Jour. Geol. Soc., Dublin, viii, 73), forming the cement of a conglomerate found as a boulder near Loughhill, county of Limerick. It is composed of small emerald-green crystals mingled with some white ones and forming mamillary concretions. Analysis by A. Gages:

$\dddot{\bar{P}}$	$\ddot{Al}$	$\ddot{\bar{Fe}}$	$\dot{Ni}$	Fl	$\dot{H}$	$\dddot{Si}$	
30·88	36·16	1·81	0·33	*tr.*	23·56	3·61	apatite 1·58, quartz 1·00=98·94

The formula deduced is $(\ddot{Al}, \ddot{\bar{Fe}})^5 \dddot{\bar{P}}^3 + 18\dot{H}$, but it is stated to be proposed merely as an expression of a single analysis.

On the formula of Kapnicite by Städeler.—Liebig's Ann., cix, 305.

WHITNEYITE, *Genth* (this Jour., [2], xxvii, 400).—Whitneyite is an arseniuret of copper containing about 12 per cent of arsenic, or 1 equivalent of arsenic to 18 of copper =copper 88·37, arsenic 11·63=100. Structure massive crystalline, fine granular. H.=3·5. G.=8·408 (at 16° C.). Lustre metallic; color pale reddish-white; tarnishes readily, becoming yellowish and changing to brown and finally to brownish-black; sometimes iridescent. Somewhat malleable. Composition according to F. A. Genth:

As 11·81	Cu 88·07	Ag and insoluble 0·33=100·21
11·41	88·19	0·47=100·07

B.B. fuses readily, giving off fumes of arsenic. Insoluble in chlorhydric acid; soluble in nitric. Found coated with red copper in Houghton Co., Michigan. One boulder weighing 40 pounds was found at the Pewabic Mine. Stated to occur in a vein four inches wide, about one mile from the Cliff Mine, at the Albion location; also found at the Minnesota mine. Named after Prof. J. D. Whitney, author of the "Mineral Wealth of the U. States."

XENOTIME [401, I, II, III].—The Castelnaudite of Damour, according to a recent analysis (Bull. Géol. [2], xiii, 542, Kopp's Jahresb. for 1857, 686), is xenotime. An analysis afforded Damour $\dddot{\bar{P}}$ 31·64, $\dot{Y}$ 60·40, $\ddot{Ti}$ and $\ddot{Zr}$ 7·40, $\ddot{\bar{U}}$ and $\ddot{\bar{Fe}}$ 1·20=100·64.

ZINC.—Native zinc has been announced as occurring on the Mittamitta river, Australia, 160 miles northeast from Melbourne. It contains a little cadmium.—Jahrb. Min., 1857, 698.

Zinc-Bloom [460, 513].—The zinc-bloom of Santander near Cumillas in Spain has been analyzed by T. Petersen and E. Voit (Ann. d. Ch. u. Pharm., cviii, 48). The following are their results: (1A) the interior of a mass and (1B) the same after a slight alteration; and also other analyses (2, 3) of the Spanish mineral by Mr. Braun (loc. cit.):

	$\ddot{C}$	Zn	$\dot{H}$
1A.	15·1	73·1	11·8 =100
1B.	13·81	74·73	11·45= 99·99
2.	13·33	73·15	12·96, mixed Calamine 1·34
3.	14·32	73·83	11·87=100·02

The constitution deduced from 1A, is 8$\dot{Zn}$, 3$\ddot{C}$, 6$\dot{H}$; from 1B, $\dot{Zn}\ddot{C}+2\dot{Zn}\dot{H}$.

Analysis of zinc-bloom from a lead mine near Romsbeck in Westphalia by C. Schnabel (Pogg., cv, 144): $\ddot{C}$ 12·30, $\dot{Zn}$ 64·04, $\dot{Cu}$ 0·62, $\dddot{\bar{Fe}}$ and $\dddot{\bar{Al}}$ 2·58, $\dot{Ca}$ 0·52, $\dot{H}$ 13·59, hygroscopic water 2·02 (by drying in a water-bath), siliceous residue 3·88, $\dot{Mg}$, $\dot{Mn}$, $\dddot{S}$ *traces*=99·45=$\dot{Zn}^{8}\ddot{C}+3\dot{H}$.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

1. *On the oxyd of ethylene.*—A. Wurtz has found that when glycol, $C_4H_4O_2+2HO$, is saturated with muriatic acid gas and heated in a closed tube water is set free and a new ether formed. The reaction is represented by the equation

$$C_4H_6O_4+HCl=C_4H_5ClO_2+2HO.$$

The new ether is a colorless neutral liquid soluble in water and boiling at 128°. The author considers this body as between glycol, $C_4H_6O_4$, and the Dutch liquid, $C_4H_4Cl_2$. A solution of potash decomposes the new ether giving chlorid of potassium and the oxyd of ethylene, $C_4H_4O_2$. The oxyd of ethylene—the true ether of glycol—is isomeric with aldehyd. It is a colorless liquid which boils at 13°·5 under a pressure of 746·5: aldehyd boils at 21°. The oxyd of ethylene is soluble in water in all proportions, and gives with bisulphite of soda a crystalline compound. It forms no crystalline compound with ammonia. Perchlorid of phosphorus converts it into Dutch liquid. We have, namely, the equation

$$C_4H_4O_2+PCl_5=C_4H_4Cl_2+PO_2Cl_3.$$

By a similar process Wurtz has prepared the oxyd of propyl-glycol, $C_6H_6O_2$. The relations between the diatomic ethers and aldehyds are best exhibited by the formulas

$$\left.\begin{matrix}C_4H_3O_2\\H\end{matrix}\right\}\text{Aldehyd}\qquad C_4H_4\,.\,O_2\qquad\text{Ethylen oxyd}$$

$$\left.\begin{matrix}C_6H_5O_2\\H\end{matrix}\right\}\text{Propionic aldehyd}\quad C_6H_6\,.\,O_2\qquad\text{Propylen oxyd.}$$

Comptes Rendus, xlviii, 101.

2. *On the chemical constitution of lactic acid.*—Kolbe has brought forward a new view of the constitution of lactic acid which connects this body in a very interesting manner with the acids homologous with formic acid. The author in the first place refers to the fact that the researches of Perkin and Duppa may be regarded as proving that glycosine is amido-acetic acid. By the action of nitrous acid upon glycosine, alanin,

&c., a series of acids is obtained homologous with lactic acid, and of which glycolic acid is the first term. Kolbe regards these acids as resulting from the acids of the formic series by the replacement of one equivalent of hydrogen in the radical by one of peroxyd of hydrogen HO_2. Thus acetic acid being

$$C_4H_3O_3 + HO$$

glycolic acid is $C_4H_2(HO_2)O_3 + HO$ and may be termed oxy-acetic acid. In like manner lactic acid is oxy-propionic acid and so on. Considered as amido-acetic acid glycosin has the formula $C_4H_2(NH_2)O_3 + HO$. To test the correctness of Kolbe's view Ulrich has instituted experiments to determine whether the acids of the formic series can be prepared from those of the glycolic series, and has succeeded in transforming lactic into propionic acid by a simple process. This consists in acting upon lactate of lime by perchlorid of phosphorus by which the chlorid of chloropropioxyl is formed. Brought into contact with water this gives chloropropionic and muriatic acids, according to the equation

$$C_6H_4ClO_2 . Cl + 2HO = C_6H_4ClO_3, HO + HCl.$$

By the action of nascent hydrogen chloropropionic acid may be converted into propionic acid. By the action of perchlorid of phosphorus upon lactate of lime Wurtz obtained a liquid which he termed chlorlactyl and to which he gave the formula $C_6H_4O_2Cl_2$. The true constitution of this liquid appears however from the above. Wurtz's view that lactic acid with the formula $C_6H_6O_4$ is bibasic also falls to the ground, if lactic is really oxypropionic acid. Kolbe further denies that glycol and its homologues and glycerin and its homologues are really alcohols, and prefers to confine this term exclusively to the hydrates of monatomic radicals. According to his view the glyoxylic acid of Debus is dioxyacetic acid, so that we have the series

Acetic acid	$C_4H_3O_3$, Ho
Oxyacetic acid	$C_4H_2(HO_2)O_3$, HO
Dioxyacetic acid	$C_4H(HO_2)_2O_3$, HO

Glyceric acid is then dioxypropionic acid. In like manner anisic acid may be regarded as oxytoluic acid. Kolbe suggests that the alcohols and aldehyds of the oxy-acids are derived from the alcohols and aldehyds of the primitive acids by simple replacement of hydrogen by HO_2, exactly like the oxy-acids themselves. It must be admitted that his views, to say the least, are very ingenious and suggestive.—*Ann. der Chemie und Pharm.*, cix, 357.

3. *On the Compounds of Valeral with Acids.*—Guthrie and Kolbe have obtained combinations of valeral—the aldehyd of valerianic acid—with acetic and benzoic acids. Both of these compounds contain two equivalents of acid to one of oxyd, but are not identical with the isomeric acetate and benzoate of amyl-glycol. Guthrie had already obtained a biacid acetate of common aldehyd. These results all go to prove distinctly that the ethers of the glycol series are not identical with the aldehyds, and fully confirm the results of Wurtz as above stated, (1). They further show, moreover, that the aldehyds in their relations to acids are referable to the type of two equivalents of water and not of two equivalents of hydrogen.

4. *On the Simple Acetate of Glycol and the preparation of Glycol.*—Atkinson has found that the bromid of elayl is easily decomposed by certain salts of potash. By the action of bromid of elayl upon acetate of potash, the author succeeded in preparing acetate of elayl in considerable quantity. The bromid and acetate are to be dissolved in equal quantities in alcohol of 85 per cent, and the whole, after being well corked, exposed for two days to the temperature of boiling water. The liquid is then to be distilled: that which passes over between 180° and 185° is the simple acetate of glycol $\left.\begin{matrix} C_4H_4 \\ C_4H_3O_2 \\ H \end{matrix}\right\} O_4$. This is a colorless oily liquid heavier than water, and miscible with this and with alcohol. Potash and baryta easily decompose this compound into glycol and an acetate. Instead of the bromid of elayl, chlorid of elayl may be employed in preparing the acetate of glycol; but in this case the mixture must be heated to 100° for three or four days at least. Glycol bears the same relation to the simple acetate of glycol, that a bibasic acid bears to its acid salt.

The author obtained glycol by distilling the acetate with caustic potash. The glycol thus obtained exhibited all the properties of that body described by Wurtz.

5. *On Organic Compounds containing Metals.*—Buckton has obtained several very interesting compounds by the action of metallic chlorids upon zinc-ethyl. Chlorid of mercury acts with great violence upon zinc-ethyl, so that the containing vessel must be cooled by means of water and the well dried chlorid added gradually. The apparatus is then to be warmed, when mercur-ethyl passes over by distillation as a heavy, colorless liquid, almost free from odor. The pure mercur-ethyl C_4H_5Hg boils between 158° and 160° C. It takes fire easily and burns with a luminous, somewhat smoky flame, giving out vapors of mercury. Dilute acids act but little upon it, but concentrated muriatic or sulphuric acids give off ethyl-hydrogen, while the salts of mercur-ethyl, $C_4H_5Hg_2$, remain in solution. The density of the vapor of this compound was found to be 9·97, its calculated density for 2 vols. would be 8·68.

The author also obtained the same compound by the action of zinc-ethyl upon the iodid of mercur-ethyl. By the action of chlorid of lead upon zinc-ethyl, Buckton obtained a radical having the formula $(C_4H_5)_2Pb$. This substance is a colorless fluid almost free from smell, insoluble in water, soluble in ether: it takes fire easily and burns with a beautiful orange colored flame, with a blue border giving off vapors of oxyd of lead. It appears to be incapable of forming salts without a partial decomposition, but the author obtained a crystalline chlorid and sulphate.

Chlorid of silver acts powerfully upon zinc-ethyl but does not yield a conjugate radical, the products of the action being ethyl, chlorid of zinc and metallic silver. When iodid of stann-ethyl is treated with zinc-ethyl and distilled, a colorless liquid passes over between 170° and 180°, which is a new stann-ethyl having the formula $(C_4H_5)_2Sn$. This body resembles the above mentioned lead compound, but is more stable. It is easily inflammable and burns like tin in the flame of the compound blowpipe. This radical differs in many respects from the stann-ethyl obtained by Frankland, which has the formula C_4H_5Sn. Muriatic acid attacks it with

difficulty; on heating there is a slow evolution of gas, and a chlorid is formed which appears to be richer in tin than the original radical. This chlorid crystallizes with difficulty and has an oily consistency at ordinary temperatures, it has a strong and penetrating smell, and on heating gives off a vapor which is very irritating to the skin. A corresponding bromid also exists, but the other salts are not yet described.

6. *On the Compounds of Organic Radicals with the Metals of the earths.*—Hallwachs and Schafarik have studied the action of iodid of ethyl upon several of the earthy metals. When magnesium is heated in a closed tube with the iodid, the metal is gradually converted into a white mass. On opening the tube gas is given off, and the white mass on heating yields a colorless volatile liquid, which has a penetrating smell of garlic. The slightest trace of air produces white clouds of magnesia, but the liquid does not take fire spontaneously. This liquid consists probably of hydro-carbons with traces of ethyl-magnesium. Finely divided aluminum foil when heated in a closed tube with twice its volume of iodid of ethyl, yields a thick syrupy liquid. On opening the tube a little gas is given off, but every drop of the liquid burns in the air magnificently, with formation of white, brown and violet vapors. The contents of the tube distilled in a current of carbonic acid yield a heavy colorless oil which has a very high boiling point, and which decomposes water most violently. This liquid is doubtless an ethyl-aluminum. The authors propose to extend their investigation to other metals. W. G.

7. *Faraday's Researches in Chemistry and Physics*—(Researches in Chemistry and Physics, by Michael Faraday, D.C.S., F.R.S., &c., &c.). London: Richard Taylor and William Francis, Printers and Publishers to the University of London. 1859. 496 pp. 8vo, with 3 plates.—The illustrious author of this volume says in his preface, "The reasons which induce me to gather together in this volume the various physical and chemical papers, scattered in the Philosophical Transactions and elsewhere, are the same as those which caused the Experimental Researches in Electricity to be collected into one series." Every student of these sciences will acknowledge a debt of gratitude to England's most distinguished philosopher for this new memorial of a life singularly fruitful of important results in physical science, while every young student will peruse with peculiar interest the early papers of Michael Faraday, written when he was as yet unknown to fame and rejoicing in the friendship and scientific guidance of Sir Humphrey Davy. The first paper, On the Native Caustic lime of Tuscany, appeared in the Quarterly Journal of Science (i, 260) in 1816. To this paper the author adds the following characteristic note.

"Reprint this paper at full length. It was at the beginning of my communications to the public, and in its results very important to me. Sir Humphrey Davy gave me the analyses to make, as a first attempt in chemistry, at a time when my fear was greater than my confidence and both far greater than my knowledge; at a time also when I had no thought of ever writing an original paper on science. The addition of his own comment and the publication of the paper encouraged me to go on, making from time to time other slight communications, some of which appear in this volume. Their transferrence from the 'Quarterly' into other journals increased my boldness; and now that forty years have elapsed and I can look back on what the successive communications have led to, I still hope, much as their character has changed, that I have not, either now or forty years ago, been too bold.—M. F."

The last paper in the present volume is the author's *Lecture on Mental Education*, in which he develops with vigorous thought his views on some of the popular delusions of the day.

II. GEOLOGY.

1. *Third Report on the Geological Survey of South Carolina;* by OSCAR M. LIEBER. 224 pp. 8vo. Columbia, S. C. Price of each Report 50 cents.—This Report treats particularly of Greenville and Pickens Districts. It gives information respecting the topography of the region, and the veins and metamorphic and eruptive rocks, and illustrates the distribution of the rocks on colored maps. A large part of the Report is occupied with a treatise on Itacolumite and the associate rocks, and their connection with the occurrence of gold. The associate rocks are *Specular schist* (a schist made up largely of specular iron), *Itabirite*, a rock consisting of arenaceous quartz and magnetite with some specular iron; *Catawbarite*, a talcose rock or schist with much magnetite; besides also an itacolumite conglomerate, and some limestone. Various reasons are given for believing that the itacolumite series are metamorphic palæozoic rocks. The origin of the gold in auriferous rocks is discussed at considerable length; but to clear up all difficulties connected with the subject, more facts are required than are yet known.

2. *Geological Survey of Canada;* Sir W. E. LOGAN, F.R.S., Director: *Figures and Descriptions of Canadian Organic Remains.* Decades I. and IV. 48 and 72 pp. 8vo, each with 10 plates. Montreal, 1859. B. Dawson. —The publication of the third Decade on the Organic Remains of Canada was announced in our last volume. Quite recently Decade I. has appeared in similar style, and with exquisite steel-plate engravings. This number is by the palæontologist Mr. J. W. Salter of London, while the engravings are by Mr. Sowerby. It takes up a portion of the Lower Silurian mollusks and illustrates the genera and species with great skill, bringing out much that is new respecting them. It represents finely the Maclurea Logani with its operculum, species of Ophileta, Raphistoma, Murchisonia, Cyclonema, Loxonema, Cyrtoceras, Ctenodonta (Hall's Tellinomya, this name being changed with good reason because the species are related not to Tellina or Mya, but to Arca), and others. There is one plate devoted to two species of Receptaculites.

Decade IV. also has just been issued. It is devoted to the Crinoids of the Lower Silurian, and is by Mr. E. Billings. Like the Decade on the Cystids it shows great success in the collection and study of the Canada Echinoderms. About fifty species are here included, five of which belong to the Chazy, and the rest to the Birdseye, Black River, Trenton, and Hudson River formations. The most remarkable species are certain forms of the Chazy, Pentremite-like in structure, for which the genus *Blastoidocrinus* is instituted. Another new genus of the Chazy is called *Palæocrinus*—the species P. striatus. It has five radiating ambulacral grooves on the summit. A second of the same rock is called *Hybocrinus;* and four are described from the Trenton. The species are well illustrated with lithographic plates.

3. *Geology of the Mexican Boundary Survey.*—The first volume of the Mexican Boundary Survey Report contains Geological Reports by Dr.

C. C. Parry and Assistant Arthur Schott, with notes by W. H. Emory; a Report on the Palæontology and Geology of the Boundary by James Hall: and Description of Cretaceous and Tertiary Fossils by T. A. Conrad, Esq.; and it is illustrated by a Geological Map by Mr. Hall, and numerous 4to plates of fossils by Conrad.

The date of the volume on the title page is 1857, but the true date of publication is the summer of 1858.

4. *Contributions to the Palæontology of New York:* being some of the results of investigations made during the years 1855, '56, '57, '58; by JAMES HALL. 18 pp., 8vo. Albany, 1859.—This pamphlet contains descriptions of three new genera—*Palœarca, Megambonia* (near Ambonychia), and *Strophostylus* (a Natica-like univalve), besides a reference of the so-called *Acroculiœ* of the Palæozoic to Conrad's genus *Platyceras*, and a citation of the characters of Conrad's genus *Platyostoma.* The first genus is the same that was called *Cyrtodonta* by Billings in the Canada Geol. Rep. for 1857, p. 179; and Billings's name therefore has the priority. Mr. Hall states that the genus is in the third volume of his Palæontology. Unfortunately the volume is not published; and much more may yet be lost to the author, as priority of *publication* is the only just basis for any claim. Mr. Hall at the same time observes that the genus *Cypricardites* of Conrad was based on a shell probably of similar character. *Cyrtodonta* is of the Arca family, but has little resemblance in its teeth to Arca, there being but a few tooth-like folds at either extremity of the hinge surface; and it is still more remote from Cypricardia; hence both the names *Palœarca* and *Cypricardites* are objectionable. To the genus, are referred the *Edmondiœ* of the first volume of Hall's Palæontology, with *Ambonychia obtusa, Cardiomorpha vetusta, Modiolopsis latus* and *M. subspatulatus* of the same volume.

5. *The Geology of Pennsylvania:* a Government Survey, with a general survey of the Geology of the United States, Essays on the Coal-formation and its fossils, and a description of the Coal-fields of North America and Great Britain; by HENRY DARWIN ROGERS, State Geologist, etc., in two vols. 4to, of 586 and 1046 pages, with numerous maps, plates, and wood-cuts. W. Blackwood & Sons, Edinburgh and London, J. B. Lippincott & Co., Philadelphia. 1858.—The geological survey of Pennsylvania by Prof. Rogers was commenced under the act of the Legislature of the State in the year 1836, and was continued on for six years. Again in 1851 it was resumed with reference to its completion, and continued until the spring of 1855, the limit allowed by the act of 1851.

The publication of the Report has been long and earnestly looked for, and it is a pleasure to see it finally issued in a style so excellent, and with a fullness of illustration and description that meets so well the demands of science and the interests of the State.

Prof. Rogers was aided by a corps of assistants, to the number of twelve through much of the time. In 1836 the assistants, as he mentions in his Preface, were John F. Frazer and James C. Booth. In 1837, they were Messrs. S. S. Haldemann, A. McKinley, C. B. Trego, J. D. Whelpley, with Dr. R. E. Rogers, chemist. In 1838 they were Messrs. H. B. Holl, A. McKinley, C. B. Trego, J. D. Whelpley, J. T. Hodge, R. M. Jackson, J. C. McKinney, P. W. Schaeffer, T. Ward, geologists, and Dr.

R. E. Rogers and M. H. Boye, chemists. In 1839 the corps was nearly the same, Peter Lesley and Dr. Henderson being added, and Messrs. Whelpley and McKinney resigning. In 1840 the corps was the same, with the addition of the draftsman, G. Lehman. In 1841 it was reduced to Messrs. McKinley, Holl, Jackson, Lesley, Boye, and Dr. Rogers. From 1851 the geological assistants were Prof. E. Desor and W. B. Rogers, Jr., and the topographers were Peter Lesley and subsequently A. A. Dalson. In the survey of a state of the extent of Pennsylvania (47,000 square miles in area) a very large part of the material for the Report must have been collected by the assistants; and Prof. Rogers acknowledges their energy and devotion in carrying forward the work.

The volumes take up first the Physical Geography of the State, as an Introductory to the Geology. Part I. treats of the Metamorphic rocks; Part II. of the Palæozoic strata. This second part is subdivided according to the rocks in the series, and under each rock into State Districts, and it occupies 480 pages of the first volume and 665 of the second. The second volume commences with the coal basins of the State, to which over 600 pages are devoted. Part III, some 30 pages in length, takes up the Mesozoic Red sandstone series, of the age of the Connecticut River Sandstone. Part IV. includes discussions of various subjects: (1) the igneous rocks and minerals, veins and ores; (2) the conditions of the physical geography attending the production of the Palæozoic strata of the United States; (3) the organic remains of the State; (4) the laws of structure of the more disturbed zones of the earth's crust; (5) classification of the several types of orographic structure illustrated in the Appalachians; (6) coal fields of the United States and British Provinces; (7) chemical constitution and physical characters of the best known coals of North America; (8) British coal-fields; (9) composition and varieties of coal; (10) methods of searching for, opening and mining coal, pursued in Pennsylvania; (11) American and European coal-fields and coal trade; (12) statistics of the iron trade.

The subject of greatest scientific interest, and that which, apart from the coal itself, is most fully illustrated, is that of the structure of the Appalachians, including the system of folds constituting the great range of mountains and the arrangement of the ridges. The facts bear on the history of all mountain making. A large number of sections illustrating this subject are contained in the second volume. We like the facts far better than the theory adopted to account for them.

The subject of coal is treated from every point of view, topographical, geological, economical, and commercial. A fine large map of the anthracite coal-fields accompanying the work is by Peter Lesley, Esq., of the geological corps connected with the survey.

The work is deficient, as the author acknowledges, in the department of Palæontology. As regards the coal plants, Prof. Rogers was fortunate in having the coöperation of Leo Lesquereux, to whose labors the work is indebted for descriptions of a large number of coal plants and a series of excellent plates illustrating them. The zoological palæontology Prof. Rogers has not undertaken to describe. A few figures are given in the chapter on organic remains, pp. 815 to 829; but they are very unsatisfactory, and are sometimes wrongly named or without any specific names.

The author has left this great department of the survey to future workers. This being so, the author had hardly a broad enough basis for the institution of a new system of nomenclature and of subdivisions for the Palæozoic formations, and especially for diverging in these respects from the New York survey, in which the subdivisions had been founded upon a thorough study of the organic remains. The names of these subdivisions, Auroral, Matinal, Levant, Surgent, and so on, can not be proved to be better than those before adopted. They are founded on the idea of a Palæozoic day, which has had no existence except in the fancy of the writer. This unfortunate framework, about which Prof. Rogers has clustered his facts, is no serious impediment to the geological reader who has a key at hand for comparison.

The work is a great one, worthy of the state which authorized the survey. It contains a vast amount of information in all its departments, and will ever rank among the most important of the reports on the geology of the United States. A large and beautiful geological map of the State accompanies it.

6. *Contributions to the History of Euphotide and Saussurite;* by T. Sterry Hunt (this Journal, [2], xxvii, 336–347).—*Erratum.*—On page 345 in the analysis of saussurite vi. the oxygen of 27·72 of alumina is given as 13·95 instead of 12·95, the true number. This correction being made, the oxygen ratios for the protoxyds, sesquioxyds and silica become 7·62 : 13·73 : 23·25, equal to 1 : 1·80 : 3·05, instead of 1 : 1·93 : 3·05. In this case therefore as well as in analysis vii, there is present a certain excess of protoxyds and silica, corresponding nearly to a tersilicate.

T. S. H.

7. *Cretaceous of New Jersey.*—In the note to page 88 of this volume, it is intended to say, that the fossil leaves of New Jersey were found in the lower part or base of the Cretaceous formation in that state, that is, beneath an extensive range of strata containing acknowledged Cretaceous fossils.

8. *Report of the Exploration of the Country between Lake Superior and the Red River Settlement, and between the latter place and the Assiniboine and Saskatchewan;* by S. J. Dawson, Esq., C. E. 45 pp. 4to. Toronto, 1859. Printed by order of the Legislative Assembly.—Besides important information on the geography of the region referred to, some geological facts of interest are brought out. The Cretaceous formation is shown to occur at a point on the Assiniboine, 150 miles west of Fort Garry. The fossils were sent to Messrs. Meek and Hayden for their opinion; and they state that among them there is an *Ammonites placenta*, a fragment of what was probably an *Inoceramus;* and an *Ostræa* near *O. congesta.* The Ammonite was received from an Indian; the latter two were from a dark shale in situ on the Assiniboine, containing fish scales, and closely resembling the Cretaceous beds No. 2 of Nebraska in Meek and Hayden's section. It is suggested that the Ammonite might have been carried north by the Indians, but in view of the other facts it is improbable. Another lot of specimens, including *Scaphites Nicoletii* and *Nautilus DeKayi*, received from another person, is said to have been found in the bed of the Saskatchewan.

9. *On the Fossil Corals of the Devonian Rocks of Canada West;* by E. Billings, F.G.S. 44 pp. 8vo. (From the Canadian Journal for March, 1859.)—This paper by Mr. Billings contains notices of forty-three species of Devonian corals. He observes that about fifty species are known to occur in the rocks, but a few of them in specimens too imperfect for description. Six of these, he states, are found in the Devonian of Europe, viz. *Favosites gothlandica*, *F. basaltica*, *F. cervicornis*, *F. polymorpha*, and *Heliophyllum Halli.* All but two of the species come from the Corniferous and Onondaga limestones. The paper is illustrated by twenty-nine figures.

10. *On some new Genera and Species of Brachiopods from the Silurian and Devonian Rocks of Canada;* by E. Billings (Rep. Canada Geol. Survey, 1858).—This paper describes and illustrates by figures two genera, *Centronella* and *Stricklandia.* The first includes the *Rhynchonella glansfagi* of Hall, from the Oriskany sandstone and Corniferous limestone in Canada, and Schoharie grit in New York. It has a loop, like Terebratula; the loop consists simply of two slender lamellæ which extend about one-half the length of the shell, where they unite at an acute angle and then become reflexed towards the beak as a thin plate. The genus *Stricklandia* includes the *Pentameras lens*, *P. liratus*, and *P. lævis* of the Middle Silurian of Britain. Three new species are described; *S. gaspiensis*, *S. canadensis*, and *S. brevis*, all from the Upper or Middle Silurian.

11. *Reports on the Geology, Botany and Zoology of Northern California and Oregon;* made to the War Department by John S. Newberry, M.D., Prof. Geol. and Chem. Columbian College, Washington, D. C. 320 pp. 4to, with numerous plates. Washington.—The Geological and Botanical Reports of Dr. Newberry, noticed in our last volume at page 123, are here collected together and published as a separate volume. On the importance and value of the researches we have already remarked. This fine volume contains, besides the geological and botanical reports, a Zoological Report, including a Report on the Fishes collected on the Survey by Dr. C. Girard; on the Zoology of the route by J. S. Newberry; on the Land Shells by W. G. Binney; and on the Reptiles by S. F. Baird; and there are numerous plates of fossils, plants, fishes, reptiles, quadrupeds, and birds.

12. *Geological Excursion.*—Col. E. Jewett of the N. Y. State Geological Museum, Albany, will make an excursion over the State of New York with such students as may choose to join him, in the course of the month of August. The party will leave Burlington, Vt., on the first Monday of August, visit Keeseville and other localities of the lowest Silurian, Montreal, Niagara Falls, Rochester and Genesee Falls, Syracuse, Utica and Trenton Falls, Schoharie, etc., and be out in all about forty days. Col. Jewett's charges are forty dollars for each student, the student bearing his own expenses. It is an excellent opportunity for any who wish to study geology in the field.

III. ASTRONOMY.

1. *Comets of* 1858.—During the year 1858 eight comets were observed. The 1st was discovered by *Tuttle* of Cambridge, Mass., Jan. 4, 1858, the 2d by *Winnecke* of Bonn, March 8, the 3d by *Tuttle*, May 2, the 4th by *Bruhns* of Berlin, May 21, the 5th (the great comet) by *Donati* of Florence, June 2, the 6th was Encke's comet on its return, the 7th was Faye's comet on its return, the 8th was discovered by Tuttle, Sept. 8.

2. *First Comet of* 1859.—This comet was first detected on the 2d of April, 1859, by Mr. Tempel at Venice. Its approximate place at $8^h\ 15^m$ April 2, was R. A. $14^h\ 30^m$, N. Decl. 71°.

3. *Numbering of the Planetoids or Asteroidal Planets.*—In numbering the planetoids a difficulty has arisen from the fact discovered by Mr. Schubert, that the planetoid detected by Mr. Goldschmidt, Sept. 9, 1857, and mistaken for *Daphne*, is undoubtedly a different body. In the *Annuaire* for 1859 of the French Board of Longitude, the planetoid detected Sept. 9, 1857, is numbered (47), and the numbers of all those subsequently discovered is increased by *one.* Mr. LeVerrier objects to this proceeding, on account of the confusion which it occasions, and maintains that the planetoid of Sept. 9, 1857, should be numbered (56).

Which plan will finally be adopted by astronomers remains to be seen. We incline to that of the Annuaire, as strictly conformed to the old rule of numbering in the order of discovery, and as likely on the whole to produce the least confusion.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Marcou's Strictures on North American Geologists.*—Mr. Marcou has issued a pamphlet of 40 pages, purporting to be a reply to the two articles on his North American Geology by James D. Dana. These two articles he has cited at length, and something more; for in the second, he has inserted, without any notice of it, nearly a page of matter from his book which the reviewer did not quote. The pamphlet presents no new basis for his claims, and calls for no reply. We merely quote a single paragraph for remark, as it has an editorial bearing. It is introduced after citing Prof. Agassiz's article from page 134 of our last volume, and is as follows:

"Mr. Dana's love of the *truth* and *duty to science* obliged him to decline publishing this article in my favor without alterations, which the author refused to make, not wishing to pass under Mr. Dana's editorial scissors; and Mr. Agassiz was obliged to threaten the withdrawal of his name from the *Journal* to induce Mr. Dana to modify his views of duty sufficiently to publish the article as it was written."

There was no refusal on the part of Mr. Dana to publish Professor Agassiz's reply, and no proposition for editorial curtailment, but only objections to its views, and a request to delay the publication, because Prof. Agassiz had not yet read the book under review, and therefore did not know what it contained and could not properly, Mr. Dana thought, write a reply to a review of it. Moreover, when Prof. Agassiz insisted upon publishing (trusting to his knowledge of Mr. Marcou's former publications), he at the same time stated that he had not the least objection to Mr. Dana's following him with his criticisms. The sequel has shown

the propriety of Mr. Dana's natural suggestion, and enables us to state, on the best of grounds, that if Prof. Agassiz had known what was in the book in question he would not have written at all. Up to the day of Prof. Agassiz's departure for Europe there has been no interruption of the cordial intercourse that has always subsisted between him and Mr. Dana; and we are confident that if he had not left the country immediately after the arrival of the pamphlet, he would himself have made a statement similar to this, in his own name.—Eds.

2. *Auroral Arch.*—During the display of the aurora borealis seen here on the evening of Friday, April 29, 1859, a well defined luminous arch or belt sprung up, spanning the sky from the western horizon nearly over to the eastern, and passing a little south of our zenith. This was its appearance at 8^h 53^m, when it was fully formed. Ten or fifteen minutes previous it was not visible, and I did not observe the process of formation. Its width was from five to six degrees in the meridional portion, but was not quite uniform or constant throughout its whole extent, and the northern edge was best defined. The westerly portion swung slowly southward while the part for twenty degrees or more about the meridian changed its place so little and so slowly, as to present an uncommonly good opportunity for fixing its place among the stars, and to render exact accuracy in time less important. At 8^h 58^m 0^s, New Haven mean time, the central line of the arch was almost precisely on δ *Leonis*, and so continued for about five minutes. Soon after this, it sailed about three degrees southward, so that the arch was just comprised between δ and θ *Leonis*. By 9^h 18^m it had drifted back and δ was again very near the middle line of the arch. The phenomenon gradually faded from the east westwardly, and by 9^h 38^m all had vanished. During this whole time the sky was clear and there was no secondary arch to embarrass the observer.

It is greatly to be desired that these and other data secured here may be united with like observations made to the north and south of New Haven, in order to determine the altitude and width of the arch. Through the kindness of Professor Loomis a few have reached me, but they are too indefinite to be useful in this respect. Loose observations at Suffield, Conn., combined with those made here seem to indicate a height of much more than 100 miles. Any one within 300 miles of this place who may have any tolerable observations on the arch is earnestly desired to publish them in this Journal, or to send them to me. E. C. Herrick.

New Haven, Conn.

3. *On Apparent Equivocal Generation;* by H. James Clark, of Cambridge, Mass. (From the Proceedings of the American Academy, Boston, May 10th, 1859).—At the close of our last social meeting I was asked if I had seen any trace of organization in the globules of the Vibrio-like fibrillæ of the muscle of Sagitta. (See p. 108 of this number). My answer was in the negative. No longer ago than yesterday I was fortunate in discovering the origin of another, or rather of several forms of these pseudo-animate bodies called Infusoria. Whilst watching the decomposition of the inner wall of the proboscis of a young *Aurelia flavidula*, our common jelly-fish, I observed that the whole component mass of cells was in violent agitation, each cell dancing zigzag about

within the plane of the wall. If any one will shake about a single layer of shot in a flat pan he can obtain an approximate idea of the appearance of this moving mass. In a perfectly healthy condition these cells lie closely side by side, and do not move individually from place to place, but yet are active on one side, which constitutes the surface of the stomach, where they are covered by vibratile cilia. As the young Aurelia grows, this wall becomes separated from the outer one, but not completely, for the cells of the two adhere to each other by elongated processes varying in number from one to six or seven. Each cell of the inner wall contains numerous red or brown granules, a few transparent globules, and a single large clear mesoblast. When decomposition ensued, these cells became still farther separated from each other and danced about in the manner which I have just described. The vibratile cilia were not observed to share in this movement; in fact I could not detect their presence, because, no doubt, they had become decomposed and fallen away; but the elongated processes, which heretofore had remained immovable and stiff, lashed about with very marked effect upon the cells to which they belonged, and caused them to change place constantly. At last the inner wall fell to pieces and every cell moved independently and in any direction. If at this time they were placed before the eyes of Ehrenberg or any one of his adherents, he would at once pronounce every cell with a single process a *Monas;* the red or brown granules would be recognized as the stomachs filled with food, the transparent globules as the empty stomachs, and the large mesoblast as the genital organ or propagative apparatus. Those with two processes would be to him a *Chilomonas* or some other genus closely related to it; those with three or four on one side would be the *Oxyrrhis* of Dujardin; and those with six or seven processes the *Hexamita* of the same author. To complete the apparently truthful determinations of these microscopists I would only have to place before them some of these cells which I have found in a state of self-division, each half possessing its genital-like mesoblast. In all their various shapes and actions, and in the mode of self-division there is a remarkable and undistinguishable resemblance to numerous moving bodies which go under the name of Infusoria, and which may be found, unconnected with any living organism, in various kinds of infusions.

4. *Note on the Polarization of the Light of Comets;* by Sir DAVID BREWSTER, (L., E. and D. Phil. Mag., April, 1859, p. 311).—Although there can be no doubt as to the accuracy of the observations of M. Arago on the indications of polarization discovered by him in the light of the comets from 1819 to 1835, there is nevertheless nothing impossible in the supposition that the light may have been polarized after arriving in the terrestrial atmosphere. In fact, when we consider that light is polarized by refraction in passing through the coats of the eye, that it is polarized by refraction at the four or six surfaces of the object-glasses of an astronomical telescope, and also in passing through the surfaces of its eye-piece, and, lastly, that the light of celestial bodies undergoes a slight polarization by the refraction of the atmosphere, we are compelled to admit that the problem of the existence of polarized light in the light of comets is not solved.

I am not aware that those who have observed traces of polarization in the light of comets have noted the direction of the plane in which it has been polarized; nevertheless without some such observation we cannot discover its cause. If the light be polarized in a plane passing through the sun, the comet, and the eye, we must infer that it is polarized by the *reflexion* of the light coming from the sun; if it be polarized in an opposite plane, the polarization may be due to the *refraction* of the atmosphere. If it be polarized *quaquaversus*, this may be due to three causes; namely, to refraction by the surfaces of the object-glasses and eye-piece, to an imperfection in the annealing of the glass of which the lenses are formed, or to the fact of one or more of the lenses being pinched in their cell. Supposing it to be an effect of the first of these causes, the openings of the object-glasses and eye-piece should be reduced to a central band, which would eliminate the light polarized in an opposite plane, and leave that which is polarized in a plane perpendicular to the direction. By turning the telescope or the lenses, the direction of the polarization would be changed.

If the polarization be produced by a defect in the annealing of the glass of which the lenses are made, as appears to be the case in one of Amici's telescopes mentioned by M. Govi, the existence of this imperfection will be rendered evident by exposing the lenses to polarized light.

If the polarization observed be due to the reflexion of the rays of the sun by the comet or its envelops, small stars will be seen more distinctly through it when the polarized light is extinguished by the application of a Nicol's prism.

Whilst I was investigating the polarization of the atmosphere, I observed the remarkable fact, that when objects situated far off in the open country are rendered indistinct by the interposition of a light mist, a part of their distinctness may be restored by viewing them through a Nicol's prism, which extinguishes all the light polarized by the mist in a plane passing through the sun, the object, and the eye of the observer. The objects thus rendered more distinct and visible were seen through that portion of the mist in which the polarization of the light reflected by them was at its maximum. This method of rendering visible objects rendered indistinct by fogs or mists may, it appears to me, receive important applications in military and naval operations.—*Comptes Rendus*, February 21, 1859, p. 384.

5. *The Iron Manufacturer's Guide to the Furnaces, Forges and Rolling Mills of the United States*, with discussion of iron as a chemical element, an American ore, and a manufactured article, in Commerce and in History; by J. P. Lesley, Sec'y of the American Iron Association, and published by authority of the same, with maps and plates. New York: John Wiley, Publisher. London: Trubner & Co. 1859. 8vo, pp. 766.—Mr. Lesley has here done a service which will be highly appreciated by all who know the national importance of the iron industry, as well as by those whose researches lead them to seek in a compendious form all the information on subjects connected with iron, to find which they have hitherto been forced to search through a wilderness of isolated authorities. Being a good geologist, familiar with the geology of Pennsylvania

and practically acquainted with what relates to the subject of iron, he was eminently fitted for the labor he has here performed. The work is divided naturally into two parts. The first is a "Directory to Iron works" in the U. S.; Furnaces and Forges and Rolling Mills. The second part (from the 264th page to the end) is a "Guide to the ores," embracing first, general considerations respecting iron as an element, and next, its ores in the United States.

In both divisions of his work Mr. Lesley has adopted a geographical order as the basis of his arrangements, subdividing the matter however according to subjects. Then in his Directory he tabulates, under the letter A, 120 anthracite blast furnaces in the U. S., of which he gives such particulars about each as are most important to be known. Tables B, E, H, K, enumerate with concise descriptions 650 charcoal furnaces, including also a few (less than 20) raw coal furnaces. Tables C, F, and I comprise the bloomeries and forges in the U. States to the number of 497. Tables D, G, J, are devoted to the rolling mills of the U. States, 224 in number. From a valuable statistical summary in the end of the volume we draw the following facts.

The entire production of raw metal in the U. S. in 1856 was a little over eight hundred thousand tons (812,917 tons), being an increase of 12 per cent from 1854. For the year 1856 the whole iron production advanced only 6 per cent over the previous year, but the anthracite branch of the manufacture reached the aggregate of 394,509 tons, being nearly one-half the whole iron product of the country, and showing an increase of *thirteen per cent* over the previous year, a fact to be explained by the conversion of charcoal furnaces into anthracite furnaces. The industry naturally tends to concentrate itself about the geological centre of fuel in Pennsylvania, a fact shown by the decline of this branch of the iron industry outside of Pennsylvania by an annual rate of over six per cent, which raises the Pennsylvania anthracite annual increase to over *twenty-two per cent.*

The commercial crisis of 1857 has been seen in a most serious falling off in the iron product of 1858, consequent on the sudden arrest of so large a number of railways in progress of construction.

The grand total of iron of all kinds, domestic and foreign, used in the United States in 1856 is set down at 1,330,548 tons, which is distributed thus:

	Domestic.	Foreign.	Total.
Rolled and hammered,	519,081	298,275	817,356
Pig iron,	337,154	55,403	392,557
	856,235	353,678	1,209,913

which results give 70 per cent *domestic* to 30 per cent *foreign* iron. The great fact demonstrated by the statistics collected by the American Iron Association are that we have nearly 1,200 efficient iron works in the U. S., producing annually about 850,000 tons of iron, the value of which in an ordinary year is fifty millions of dollars, of which the large sum of $35,000,000 is expended for labor alone.

Mr. Whitney, in his Metallic wealth of the United States, estimates the iron product of the world at 5,817,000 tons, of which 1,000,000 are set down for the U. S., Great Britain producing that year 3,000,000.

When we remember that so late as 1845 the total product of the United States in iron had not reached half a million tons (486,000) and that in 1850 it was only 600,000 tons, it will be seen that the progress in this important industry in the first six years of this decade has been at the rate of over twenty per centum per annum. The operation of this law of increase will soon, it would seem, put an end to all importation of iron, and points even to an export of this great staple at no distant day. The stock and variety of iron ores and coal in the United States is such as seems adequate to meet the demands of the world as fast as the laws of commerce will permit their development.

6. *Mammals of North America:* the descriptions of species based chiefly on the collections in the Museum of the Smithsonian Institution; by SPENCER F. BAIRD, Assistant Secretary of the Smithsonian Institution. 764 pp., 4to, with 87 4to plates of original figures, illustrating the Genera and Species, and including details of external form and osteology. Philadelphia, J. B. Lippincott & Co. 1859.—Professor Baird has here placed before the country a comprehensive Treatise on the Mammals or Quadrupeds of the country, well illustrated by plates. And from the collections under the author's hands, and our knowledge of his care and ability, we are sure that we now have one branch of American zoology thoroughly discussed. The first part of this volume has already been noticed in this Journal (vol. xxvi, 142), it consisting of the Report on Mammals in the Pacific Railroad Survey. To this is added the Report on the Mammals of the United States and Mexican Boundary Survey. The descriptions are given with full details, and in the plates there are illustrations relating to 161 species. The libraries of the country should be supplied with this great work.

7. *Rational Cosmology, or the Eternal Principles and the Necessary Laws of the Universe;* by LAURENS P. HICKOK, D.D., Union College. New York, 1858.—Rational cosmology comes reasonably within the range of this Journal, but not the system of Prof. Hickok, which is decidedly irrational. He claims to educe a philosophy of nature from the empty reason instead of through induction, and has proved the fallacy of the method by educing laws that are not the laws of nature. The author, unwittingly, drew upon the furniture of his own mind, unaware that it was defective and had been derived by imperfect reason from the base earth. Prof. Alexander of Princeton has well set forth the errors of the "Rational Cosmology" in the Princeton Review for April, 1859; and we would commend the article to all interested in the subject. The laws of nature when fully learned and understood will appear to the reason like the evolution of one thought. But reason should not deceive itself and suppose, because it can perceive this unity, that it can therefore evolve of itself the thought and the system of laws.

8. *American Association for the Advancement of Science.*—The next meeting of the Scientific Association was appointed to be held at Springfield, Mass., commencing with the first Wednesday of August. Prof. Stephen Alexander of Princeton is President for the year, and Prof. Edward Hitchcock Vice-President.

9. *Synopsis of the Fresh-water Fishes of the Western Portion of the Island of Trinidad, W. I.;* by THEODORE GILL. 70 pp. 8vo. H. Bailliere, New York City. (From the Annals of the Lyceum of Natural History, New York, Vol. VI.)

10. *Notes on North American Crustacea,* No. I.; by WM. STIMPSON. 48 pp. 8vo, with 1 plate (from the Annals of the Lyceum Nat. Hist. of New York for March, 1858).—We have barely space to announce the appearance of this first part of a systematic account of North American Crustacea. It commences with the Maioids and closes with the Pagurus family among the Anomoura.

JAMES D. FORBES: Occasional papers on the theory of glaciers, now first collected and chronologically arranged with a prefatory note on the recent progress and present aspect of the theory. 278 pp. Edinburgh, 1859. A. & C. Black.

R. I. MURCHISON: Siluria; the History of the oldest fossiliferous rocks and their foundations, with a brief sketch of the distribution of gold over the earth. 3d edition. London, 1859. Murray.

Rev. JOHN FLEMING: The Lithology of Edinburgh. Edinburgh.

C. M. TRACY: Studies of the Essex Flora; a complete enumeration of all plants found wild within the limits of Lynn, Mass., and the towns adjoining. 88 pp. 8vo. 1858.

PROCEEDINGS BOSTON SOC. NAT. HIST. 1859.—p. 17, Birds of Florida, continued; *Dr. H. Bryant.*—p. 21, Distribution and habits of the Summer Yellow-bird; *Dr. Brewer.*—p. 22, Minerals of the gold region of Georgia; *C. T. Jackson.*—p. 23, On some new Actinoid Polyps of the Coast of the United States; *Agassiz.*—p. 26, Diatoms of West Roxbury; *C. Stodder.*—p. 28, A new Helix from Maine; *T. J. Whittemore.*—p. 29, On the corrosive properties of guano; *C. T. Jackson.*—p. 31, Origin of the Copper and Silver of the Lake Superior region; *C. T. Jackson.*—p. 33, Menobranchus in the Mohawk River; *J. Lewis.*—p. 34, Note on species of Pomotis; *F. W. Putnam.*—p. 38, On the recent eruption of Mauna Loa; *H. M. Lyman.*—Descriptions of new shells; *A. A. Gould.*—p. 45, Note on minerals formed from springs; *C. T. Jackson.*—p. 47, Note on thickness of the earth's crust; *W. B. Rogers.*—p. 48, Tuckahoe contains no starch; *C. T. Jackson.*

PROCEEDINGS ACAD. NAT. SCI. PHILADELPHIA, 1859.—p. 91, Tooth of a Mastodon from Honduras, probably of the same species as the common U. S. Mastodon; also on Mosasaurus bones from New Jersey; *J. Leidy.*—p. 93, On the species of Nicotiana; *J. LeConte.*—p. 98, Notes on Coluber calligaster of Say; *R. Kennicott.*—p. 100, Ichthyological Notices; *C. Girard.*—p. 104, Catalogue of birds of New Mexico; *T. C. Henry.*—p. 110, Teeth of reptiles and other fossils in the Triassic of Pennsylvania; teeth near those of Saurichthys and others of Diplodus from a locality at Bethany in Virginia; teeth of Pycnodus, Otodus and Galeocerdo, palate and teeth of Pycnodus and fragments of jaws of Mosasaurus from the Green Sand of Monmouth Co., N. J.; *J. Leidy.*—p. 111, Sombrero guano; skull of Ursus Americanus, associated with bones of Mastodon at Oxford, Miss.; *J. Leidy.*—Eight new species of Unionidæ; *I. Lea.*—p. 113, Ichthyological notices; *C. Girard.*—p. 122, On the primary divisions of the Salamandridæ; *E. D. Cope.*—p. 128, On the genus Callionymus of Authors; *T. Gill.*—p. 131, Description of Hyporhamphus, a genus of fishes allied to Hemirhamphus; *T. Gill.*—p. 132. On Dactyloscopus and Leptoscopus, two genera of the family of Uroscopidæ; *T. Gill.*—p. 133, Catalogue of Birds collected in Western Africa by P. B. Duchaillu; *J. Cassin.*—p. 144, Notes on a collection of Japanese Fishes; *T. Gill.*—p. 151, Descriptions of twelve new species of exotic Unionidæ; *I. Lea.*—p. 154, Descriptions of new species of Uniones from Georgia and other Southern States; *I. Lea.*—p. 155, Description of a third genus of Hemirhamphinæ; *T. Gill.*—p. 157, Ichthyological Notices; *C. Girard.*

Bibliographical Notices by Prof. Nicklès.

MALLET & BACHELIER of Paris offer the following works:

Treatise on Optical Physics, by Billet, Professor of Physics in the Scientific Faculty of Dijon. Vol. II.—We have already announced Vol. I. of this remarkable

work, which embraces all that relates to the higher optics, to which M. Billet has devoted himself. Vol. II. is quite as important and instructive. The labors of Thomson, Young, and Fresnel have contributed most of the material.

Photographic Chemistry, by Barreswill and Davanne, in 8vo, 2d edition.—Within a few years the first edition of this work, announced by us, has been exhausted and a second edition rendered necessary. The authors have introduced into it all the latest improvements, and it contains many unpublished facts. Following the progress in photography, they have attached great importance to the processes on collodion and on paper, and placed the daguerrotype in the second rank.

Aluminium, its nature, manufacture and applications, by H. St. Claire Deville, in 8vo, 176 pages, with plates.—This important work has been mentioned in our communication on page 126. It contains the whole history of the subject, and communicates many interesting details. Notwithstanding that the French government and private individuals have contributed to the researches on aluminium, Deville informs us that he has sacrificed to it a large part of his personal fortune.

Physiological investigations on the animalcules of vegetable infusions compared with the elementary organisms of plants, by Paul Laurent, inspector of forests, &c. Vol. 2. 4to, with plates. Paris: T. B. Bailliere.—We have announced Vol. 1, which appeared in 1854. This volume, in which micrographic observations play so important a part, treats especially of the elementary organisms of plants. Paul Laurent was for thirty years professor in the forest school of Nancy; he has trained many pupils, and some of them are, like himself, devoted to microscopic studies.

Scientific Essays, by Victor Meunier, in 12 nos. of 212 pages. Vol. 3d.—We have already spoken of this work of popular science, devoted especially to inventions and discoveries which have not been made by those who were properly scientific men. The weekly journal, L'Amis des Sciences, by the same author, is devoted to the same end. It happens at the present moment, that this journal has entered into the great contest between pan-spermists and hetero-genists, and favors the theory of spontaneous generation. Victor Meunier is otherwise a competent man, and was the favorite pupil of the great naturalist Stephen Geoffroy Saint Hilaire.

The Moniteur des Hospitaux.—Medico-Surgical Review of Paris.—This journal, which appears three times a week, is one of the most celebrated medical periodicals of Paris. Its chief editor, N. de Castelnau, occupies an eminent rank in medical criticism. Every week this journal presents a critical "fenilleton" entitled "medical darts," in which the editor, Dr. Toulin, with great spirit attacks charlatanism in matters of medicine and pharmacy, as well as whatever is absurd in cotemporary physicians.

Annals of the Paris Observatory, published by Leverrier. Vol. 4, in 4to. Paris: Mallet & Bachelier.—This important volume is devoted to the theory and to tables of the apparent motion of the sun; it is entirely from the hand of M. Leverrier, who has impressed it with the stamp of his own genius.

Catalytic Force, or Investigations on the Phenomena of Contact, by T. L. Phipson. A pamphlet in 4to of 34 pages.—This work was crowned by the Holland Society of Sciences in 1858. The author examines with much care the phenomena called catalytic; he explains these phenomena on a ground-work of known facts, and he concludes that catalysis exists only in name, and that the force known under the name is a pure fiction.

Plate 1.

IMPROVED DEEP SEA SOUNDING APPARATUS

Fig 1. Scale = $\frac{1}{6}$

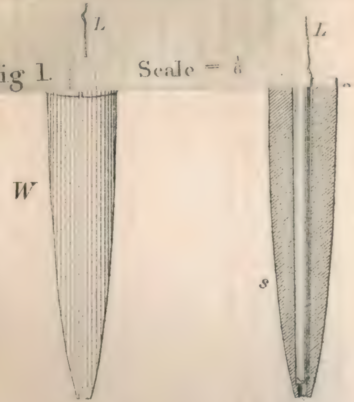
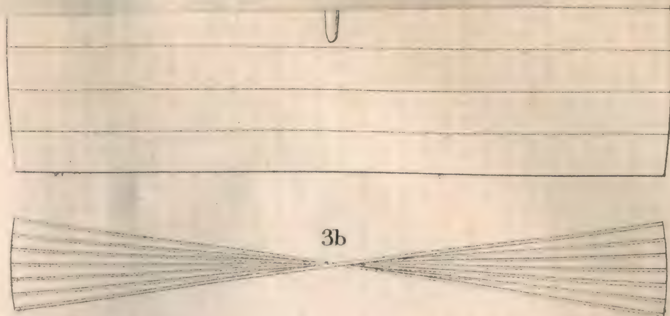


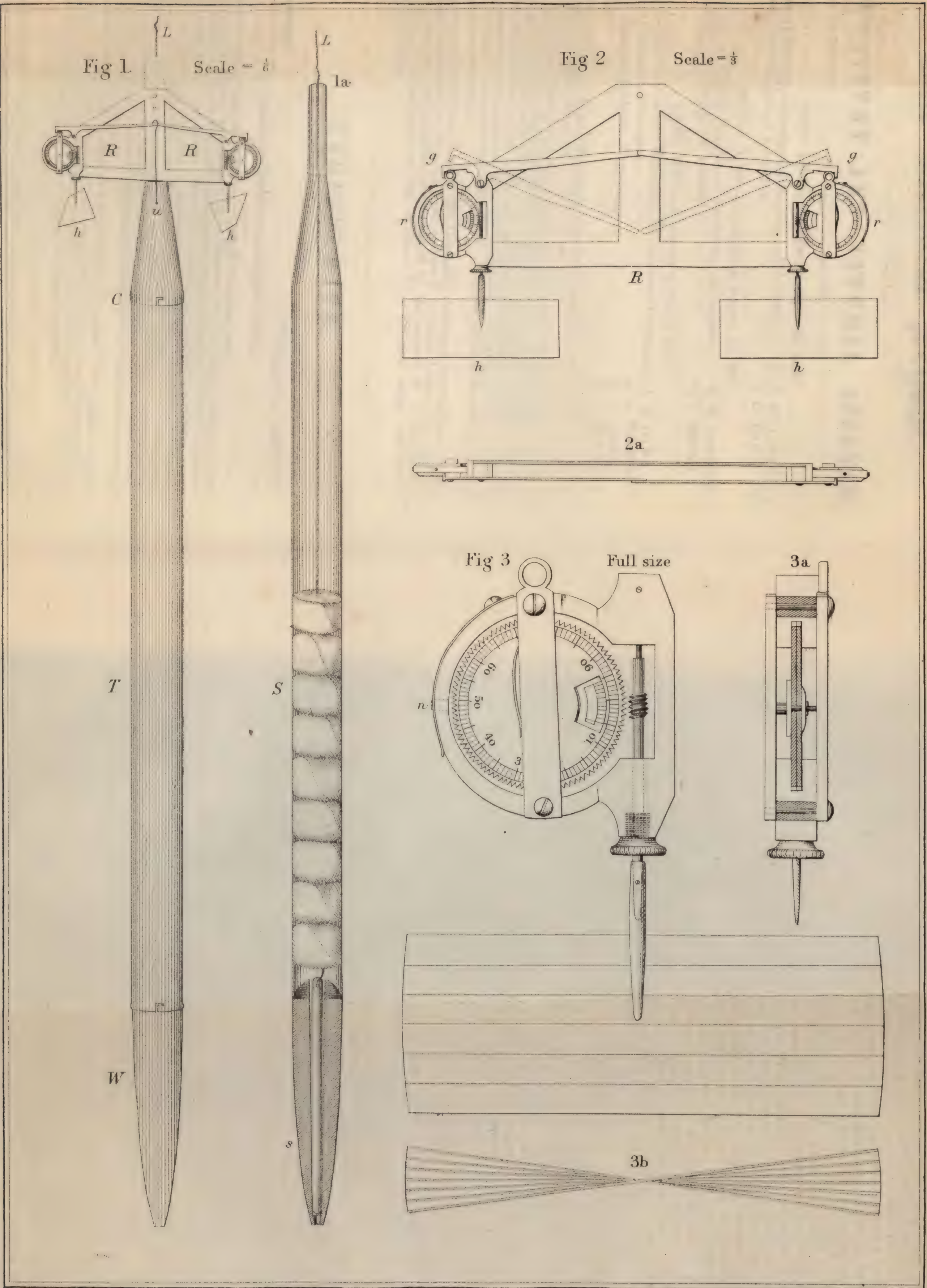
Fig 2 Scale = $\frac{1}{3}$



Lith of J. Bien, 60 Fulton St.

Eng^d. by R. F. Bartle

IMPROVED DEEP SEA SOUNDING APPARATUS



Lith of J.Bien, 60 Fulton St.

Engd. by R.F. Bartle

Yale Scientific School.

CHEMISTRY AND NATURAL SCIENCE.

FIRST TERM.—(Commencing Sept. 14th, 1859.)

General Chemistry,—[Academical lectures]—(50 lectures), - - B. SILLIMAN, JR.
Geology, (45 lectures and recitations), - - - - - - J. D. DANA.

SECOND TERM.—(Commencing January 4th, 1860.)

Chemistry and General Principles of Agriculture, (30 lectures), S. W. JOHNSON.
Chemistry of the Metals, (30 lectures), - - - - - - G. J. BRUSH.

THIRD TERM.—(Commencing May 2d, 1860).

Crystallography and General Mineralogy, (44 lectures and recitations), J. D. DANA.
Organic Chemistry, (30 lectures), - - - - - - - - J. A. PORTER.
Use of Blowpipe (20 hours of practice), - - - - - - G. J. BRUSH.
Botany, - - - - - - - - - - - - - - D. C. EATON.

The Lectures on Natural Philosophy, Astronomy and Meteorology in the Academical Department are also accessible.

The *Analytical Laboratory* is fully equipped with means of practical instruction in all branches of Analytical and Experimental Chemistry, and is open daily from 9 A. M. to 5 P. M throughout the academic year. Students work through a course of Qualitative and Quantitative Analysis, and are afterwards guided in the study of any special department of Experimental Chemistry, or in original investigations. Previous study of chemistry is highly desirable, but not essential to admission. A special course in Qualitative Analysis will be given each term.

EXPENSES.—Matriculation fee, $3. For Laboratory instruction, and supplies of ordinary reagents and materials, fires, apparatus, and use of Chemical Library, $51 per term. Cost of apparatus and materials to be supplied by the student, $5 to $10 per term. Lectures—to Laboratory students, free; to others, $3 to $10 each course. All fees to be paid in advance.

ENGINEERING.

Engineering, - - - - - - - - - - - WILLIAM A. NORTON.

ASSISTANT INSTRUCTOR—LOUIS BAIL.

The instruction in Engineering extends through the whole year.

Course of Instruction.—Surveying in all its branches, with the use of instruments, and systematic exercises in the field;—Drawing, topographical, geometrical, mechanical, architectural; with shading and tinting; Descriptive Geometry, Shades and Shadows, Linear Perspective, Isometrical Projection; Applications of Descriptive Geometry to Masonry and Stone-cutting, and to Civil and Mechanical Engineering, generally;—Principles of Architecture;—Analytical Geometry, and the Differential and Integral Calculus;—Mechanics, with Applications to Machinery and Engineering;—the Science of Construction;—Engineering Fieldwork;—Use of Astronomical Instruments for the determination of time, latitude and longitude, &c.

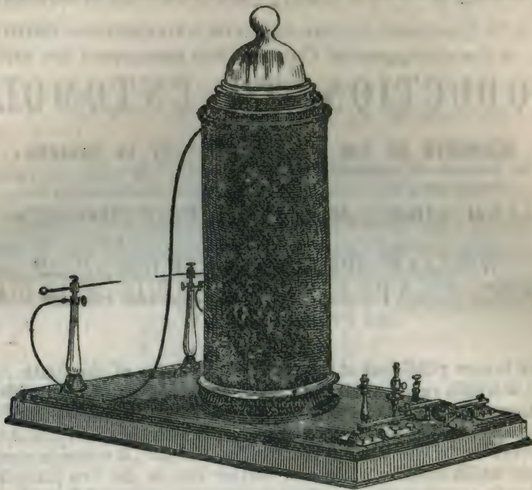
The student may pursue a partial or a full course, at his option. The studies required for admission to the full course are, Arithmetic, Algebra, Geometry, and Trigonometry.

Tuition fee, for the full course of each term, $33;—to be paid in advance. Fee for the course of Surveying alone, $12. No charge for incidental expenses.

Students who pass a satisfactory examination in either of the above Departments, are entitled to the degree of Bachelor of Philosophy, after being two years connected with the School.

[*Yale College, New Haven, July*, 1859.

PHILOSOPHICAL INSTRUMENTS.



E. S. RITCHIE

INVITES the attention of Professors and Teachers to the superior quality and finish of the Instruments manufactured by him for the use of

COLLEGES AND SCHOOLS,

illustrating all branches of Physical Science, and embracing all sizes of Apparatus, from the largest and most powerful to as small as is compatible with efficiency.

Several important Instruments have been lately added, and it is his determination to make all such new Instruments as the advances of Science may require. Above is a cut of RITCHIE'S

Improved Form of the Ruhmkorff Apparatus,

which he is prepared to furnish, capable of throwing a spark from one to twelve inches.

E. S. R. has received permission from many scientific gentlemen of the highest standing, to refer to them, including

Prof. ROGERS, Boston,
Prof. LOVERING, Harvard,
Prof. SNELL, Amherst,
Prof. BARTLETT, U. S. Military Academy.
Prof. SMITH, Kenyon.
Prof. DOREMUS, Medical College, N. York.
Prof. GIBBS, Free Academy, N. Y.
Prof. ROGERS, University of Penn.
Prof. GREENE, Rensselaer Institute.
Prof. MEANS, Oxford, Ga.

Prest. BARNARD, University of Mississippi.

He invites all interested, whether purchasers or not, to call and examine his Instruments at his rooms,

No. 313 Washington Street, Boston.

July, 1857.—[tf.

ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

In consequence of the increase in size and cost of the Proceedings of the Academy, the subscription price from January, 1860, will be two dollars annually, and the completed volumes for 1857, '8 and '9, will be furnished at two dollars each, and the eight volumes previously published at two dollars per volume, as heretofore.

Under authority of the following resolutions, adopted by the Academy, March 29th and April 26th, 1859, the Committee on the Publication Fund, is prepared to receive subscriptions.

"*Resolved*, That the Academy will establish a permanent fund, to be called the Publication Fund, the principal of which shall always be kept invested in good securities, and the interest accruing thereupon shall be applied to the payment of the expenses of publishing such matter, stated or occasional, as the Academy may think proper to issue.

"*Resolved*, That every person who shall pay to the Treasurer of the Academy, the sum of twenty-five dollars in aid of this fund, shall be entitled to receive a copy of the Proceedings during life, and any person who shall in like manner, pay the sum of fifty dollars additional, shall be entitled to receive a copy of the Journal during life."

Your aid in establishing this fund is respectfully requested.

Address, W. S. VAUX,
Treasurer of Committee,
Acad. Nat. Sciences, corner of Broad and Sansom Streets, Philadelphia.

☞ Subscribers who do not wish to continue the Proceedings at the advanced rate, will please notify W. S. Vaux, at as early a period as possible.

The next No. of this Journal will be published on the first of Sept.

CONTENTS.

(For remainder of Contents, see third page of Cover.)